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The Materials Handbook

GUIDELINES FOR SUSTAINABLE AFFORDABLE HOUSING

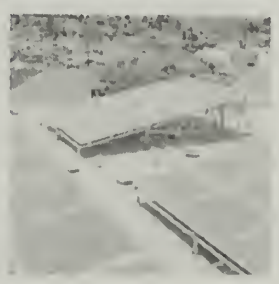

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TABLE OF CONTENTS

Acknowledgements	1
Key Concepts and Challenges	3
Introduction	5
Key Concepts In Affordable Housing	11
Challenges In Affordable Housing	23
Design	33
Exterior Spaces	35
Common Areas	49
Service Areas	75
Individual Units	91
Materials	109
Finishes	111
Electrical	139
Wood	155
Exterior Envelope	167
Site	173
Resources	177

Pictured on the cover: Top - Drachma Housing in West Oakland: dual glazed vinyl windows in historic rehab. Photo by Dan Adams.
Middle - Rich Sorro Commons in San Francisco: stained concrete flooring in lobby. Photo by Gonzalo Castro.
Bottom - Nueva Vista Family Housing in Santa Cruz: rooftop photovoltaic panels. Photo by Fred Pollack.

ACKNOWLEDGEMENTS

The content of this Handbook has been compiled and formatted by Rob Rich and Anne Romero of the San Francisco Mayor's Office of Housing, and Dan Adams, Rose McNulty, and Irene Yang of Asian Neighborhood Design. However, the information presented in the pages that follow represents the input of literally hundreds of San Francisco Bay Area affordable housing practitioners: non-profit developers, architects, city officials, property management staff, and builders whose knowledge and experience in affordable housing development has not only been invaluable to the creation of this Handbook, but more importantly, essential to the creation and management of thousands of quality affordable housing units in the Bay Area. It is to this community of affordable housing specialists that we owe our first debt of gratitude.

The process of compiling the initial version of the Handbook began in 1996 when the San Francisco Mayor's Office of Housing (MOH) and Asian Neighborhood Design (AND) sponsored a series of seminars. A central goal of those initial seminars was to provide an opportunity for developers, designers and property managers to sit down together and share their experiences regarding what worked and what didn't work in multifamily affordable housing. Quotes, insights, anecdotes and admonitions from this first group of workshop participants still ring true and we have continued to draw and reflect upon their sage recommendations throughout this updated version of the Handbook.

In order to update the Handbook, AND and MOH collaborated once again in 2001 holding a series of workshops which investigated the potential for incorporating emerging "green" technologies and sustainable building techniques within high density affordable housing in San Francisco. Presenters at the four part series were: Kevin Drew (SF Environment), Gary Ashbrook (Sanitary Fill Company), Jim Steinmetz (Reusable Lumber), Bobbi Sue Hood (Hood Miller Assoc.), Antonia Bava (Antonia Bava Landscape Architects), Larry Strain (Siegel and Strain Architects), Bill Burke (Pacific Energy Center), Mark Palmer (SF Environment), Raymond Brooks (Raymond Brooks Engineers), Jim Fagler (AND), Rick Diamond (Lawrence Berkeley National Laboratory), Marc Delany (Ghoti & Co.), Glenn Kellerer (Chinatown CDC), Scott Smith (Roberts-Obayashi), Lynn Simon (Simon & Assoc.), Chuck Palley and Paul Kohler (Cahill Contractors), Doug Shoemaker (NPH), Pat Dyas (State of California), and Joel Lipski (MOH). Their interest in and knowledge of green building and affordable housing has served as inspiration for this document and we have attempted to translate much of the content of their presentations to these pages.

The drafting of this work could not have been accomplished without the important collaboration and considered input of several individuals including: Gonzalo Castro, Joel Lipski, and Mae Chan Frey. We were also very fortunate to work with Amy Dryden, our tireless intern who provided valuable research and writing on a variety of green building materials and construction methods. In addition, several organizations helped immeasurably by freely sharing their expertise and encouragement, including: SF Environment, Pacific Energy Center (PEC), Alameda County Waste Management Authority (ACWMA), Non-Profit Housing Association (NPH), Rebuild America, Strategic Energy Innovations, and the Green Affordable Housing Coalition. Also, the Enterprise Foundation, through the Frederick P. Rose Architectural Fellowship, provided financial support for Dan Adams' work at Asian Neighborhood Design during much of the drafting of the Handbook.

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KEY CONCEPTS AND CHALLENGES

Introduction 5

Sustainable Building 5

Long Term Affordability 6

Life Cycle Cost Analysis 6

Whole Building Analysis 7

Organization of the Handbook 8

Key Concepts in Affordable Housing

Durability (and Ease of Maintenance) 11

Energy Efficiency 12

Indoor Air Quality ("IAQ") 14

Recycling 18

Challenges in Affordable Housing

Funding For Sustainable Buildings 23

Comparing Initial Costs to Other Buildings 27

Changing Standard Construction Practices 27

Rehabilitation of Existing Buildings 28

INTRODUCTION

The purpose of the *Materials Handbook: Guidelines for Sustainable Affordable Housing* ("Handbook") is to share knowledge about building materials and design strategies that have been used to create healthy, high quality, multifamily affordable housing for low income people in San Francisco. A guiding principle of the Handbook is that projects benefit when developers actively participate in important design decisions. While the need for this participation may seem obvious, developers operate in a world of multiple demands. When faced with competing deadlines, it can be tempting to let the architect "take care of the design." Without undermining the designer's critical role, the developer can actively participate in the design process in order to help ensure that buildings are healthy, high quality, and affordable for the long term.

The Handbook strongly encourages project managers to foster an active and ongoing dialogue among stakeholders throughout the design and value engineering process. No one better understands what works (and what doesn't) in the design and operation of affordable housing than the people who live there and those who provide the maintenance, asset management and support services for these buildings. Developers need to draw upon the collective experience of these stakeholders to replicate elements that are working well, and to avoid some of the problems that have arisen on other projects. While the Handbook may help to highlight some critical issues that should be carefully considered, it is not a substitute for dialogue between the development, property management and support services teams.

Sustainable Buildings

Building housing that is healthy, high quality and affordable for the long term is consistent with many of the ideals of green[1] or sustainable[2] development. For example, improving energy efficiency helps to maintain affordability by reducing utility bills/operating costs and protecting the building from some of the volatility of fluctuating energy markets. Improving energy efficiency is also a core element of green design because a reduction in energy usage typically results in a reduction in green house gas emissions. However, due to the strict funding limitations under which affordable housing operates, the concept of "sustainable" used in this Handbook primarily focuses on measures that directly improve the health of the tenants and the affordability of buildings over time, rather than on measures that provide important, yet somewhat diffuse, environmental benefits.[3]

The Handbook does not establish rigid design requirements. These are only guidelines intended to help spark a dialog that leads to more informed design decisions. It only addresses selected issues, and even then it does not define specific solutions to design questions. Rather, the Handbook is best used as a "living document" to be augmented and annotated by the user. In addition, for those seeking to create or update their own "standard specifications,"[4] it may help identify some issues that deserve input from other affordable housing stakeholders.

Long Term Affordability

A central premise of the Handbook is that affordable housing should be designed to remain "affordable" over the long term, and ideally, for the useful life of the building. While such long term affordability depends in part on keeping initial construction costs as low as possible, long term operating and replacement cost savings are equally important.

In light of the scarcity of subsidies and in the context of extraordinarily high development costs in the Bay Area compared to other areas in the state and country, keeping a lid on initial construction costs is one way to maximize the effectiveness of those subsidies. If an "economical" construction budget results in a development that needs additional capital subsidies from time to time because a lack of durability or efficiency places unsupportable burdens on replacement reserves, and operating costs are too high relative to income to support capital improvement financing, then it is falsely "economical." The scarcity of capital subsidies is only exacerbated by developing housing that needs periodic infusions of additional subsidies to maintain and preserve its affordability, subsidies that might otherwise be used for new housing.

Since the goal of long term affordability is to provide healthy, high quality, affordable housing that can be operated over time on relatively low operating income, every element of a development's planning and implementation should be undertaken with an eye toward minimizing the need for operating income. The very purpose of capital subsidies for initial construction and development is to reduce or eliminate long term debt and the burden it places on operating income. Similarly, sustainable development activities that over the long term reduce the need for operating income should be encouraged. "Life Cycle Costs Analysis" (described below) may be used to justify higher construction costs when it can be demonstrated that increasing the initial investment will generate long-term savings through lower operating and replacement costs, and thereby promote affordability.

Life Cycle Cost Analysis

Life cycle cost analysis is a tool to help evaluate the long term financial consequences of design decisions, including decisions involving durability and energy efficiency. "Life cycle costs"[5] typically include an analysis of three elements: initial cost, operating costs, and useful life (replacement costs). Perhaps the simplest measure of life cycle costs is the "payback period," or the time it takes to recoup a marginal additional investment through savings captured over time.

payback calculation...

Simple payback can be calculated using the following formula:

P = I/S

P = Payback (typically represented in years)
I = Initial cost differential (the additional cost of the proposed feature)
S = Savings per year, including energy and maintenance costs

Case Study: A comparison of residential washing machines

A nonprofit developer[6] compared the life cycle costs of "regular" washing machines (those that comply with minimum efficiency standards) with "Energy Star" models[7] in order to determine how long it would take for the utility savings generated by the Energy Star models to "payback" ("P") the higher initial cost. The initial cost to purchase each Energy Star washer ("I") was approximately $324 more than base models.

The Energy Star model was estimated to use about ½ the electricity of the base model (with electrical savings calculated at $55/yr). In addition, the Energy Star model used much less water than a conventional clothes washer, conserving about ½ the gas used by the base model to heat the water for washing clothes (with gas savings calculated at $20/yr). Consequently, the combined utility savings for each Energy Star washer was estimated at $75 per year ("S").

P = $324/$75
P = 4.3 years

Therefore it was estimated that it would take about 4.3 years of utility savings to "payback" the initial price difference between the base and Energy Star model.[8] Since the useful life of the appliance (estimated at 12 years)[9] far exceeded the payback period (4.3 years), the payback period analysis helped to justify a higher initial budget for washing machines.[10]

Whole Building Analysis

Although the "initial cost" of a proposed design element is certainly important, it can be somewhat elusive. An accurate analysis of initial costs requires a "whole building analysis," which is the consideration of the effects that design decisions have on interrelated building systems.[11] For example, at first blush, the initial cost of electric baseboard heat appears quite low because electric resistance heaters themselves are relatively inexpensive. However, a building using electric heat may need to have a larger supply of electricity then would otherwise be required, including larger sub-panels and potentially even a transformer. In addition, electric baseboard heat consumes so much energy that the California Building Code ("Code")[12] only permits it when the design realizes sufficient energy efficiencies elsewhere to make up for the energy consumption of electric resistance heat.[13] Therefore, a building using electric baseboard heaters may need to provide windows, insulation or water heaters that are more efficient than the Code otherwise requires. The marginal costs of increased electrical capacity and required energy efficiency measures are appropriately considered part of the initial cost of electric baseboard heat under the whole building analysis.

Organization of the Handbook

The three sections of the Handbook are meant to flow from (1) a general introduction of concepts to (2) the application of those concepts to different areas of a building to (3) a more detailed description of selected building materials and components. The first section, **Key Concepts and Challenges**, introduces principles that guide the analyses in subsequent sections. The four Key Concepts are: durability and ease of maintenance, energy efficiency, indoor air quality, and recycling. The first section closes with a discussion of common challenges that project managers frequently encounter: funding for sustainable buildings, comparing costs, changing standard construction practices, and the rehabilitation of existing buildings.

The second section, **Design**, looks at different building areas by location and use. By sharing lessons learned, this section can help the reader to incorporate proven features while avoiding some of the problems that affordable housing projects in San Francisco have experienced. For example, intensively used common areas, such as lobbies or corridors, need durable finishes that are easily cleanable. In addition, some materials that are mentioned in this section, such as real linoleum (a durable, easily cleanable, natural floor covering), are cross-referenced for a more detailed analysis in section three.

The third and final section, **Materials**, provides a more detailed evaluation of selected building materials and components. Once again, the evaluation is guided by the key concepts introduced in the first section. Utilizing a flexible format, selected materials and components are described, the advantages and disadvantages are discussed, recommendations or environmental considerations are raised, and links are provided to other resources for additional information.

1 For a good definition of "Green Building," see BuildingGreen.com (publishers of Environmental Building News), "What is Green Building" at *http://www.buildinggreen.com/about/whatsgb.html.*

2 For a good definition of "Sustainable Development," see Energy Efficiency and Renewable Energy Network (EREN), "Overview of Sustainability" at *http://www.sustainable.doe.gov/overview/ovintro.shtml.*

3 Most multifamily affordable housing in San Francisco meets sustainability goals for the building site, such as density, brownfield redevelopment, and access to public transportation. For more information on these, and other sustainable development considerations, see "LEED Green Building Rating System," US Green Building Council, *www.usgbc.org/Docs/LEEDdocs/LEED_RS_v2-1.pdf.*

4 A "standard specification" is a document prepared by a developer based on their past experience that defines materials, fixtures and equipment that should be used on future projects. It can be an excellent tool to reduce design fees and operating costs. Developers that know what they want and communicate that in advance to their designers save valuable design time, and insure consistency across buildings. It is important to regularly update standard specifications because building standards change and developers gain new design insights over time.

5 The definition of "Life Cycle Costs" used in the Handbook is based on the Federal Energy Management Program (FEMP) that evaluates the cost effectiveness of equipment purchases for Federal facilities. For further information, see http://www.eere.energy.gov/femp/. It should be distinguished from the similarly titled "Life Cycle Assessment" that considers broader "cradle to grave" environmental impacts including "embodied energy" and environmental effects of manufacturing. For further information regarding Life Cycle Assessment, see the Building for Environmental and Economic Sustainability (BEES) web page and software, *http://www.bfrl.nist.gov/oae/software/bees/buzz.html.*

6 The life cycle cost analysis was performed in June 2002 for Mercy Housing California, by Brown,Vence & Associates under contract with the SF Department of the Environment, for the Carter Terrace family housing development.

7 For more information regarding the Energy Star program, see *www.energystar.gov.*

8 The energy efficiency requirements for appliances, and the standards for "Energy Star" rated appliances, change regularly. Therefore, this example may not be applicable for subsequent appliance standards or Energy Star ratings. However, Energy Star rated models will always provide greater energy efficiency than baseline models, with operating savings accruing to the building.

9 According to Energy Star's "Savings Calculator," washing machines are assumed to have a useful life of 12 years. *www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CW_savings_calc.xls.*

10 If the estimated payback period exceeds the useful life of the item, then the investment cannot be justified solely on a life cycle cost basis.

11 For a good overview of Whole Building Analysis (also known as "Whole Building Design", or "Integrated Design"), as well as links to tools for more sophisticated Life Cycle Cost Analyses, see *www.eere.energy.gov/buildings/design/wholebuilding/index.cfm.*

12 Also commonly referred to as "Title 24."

13 Unlike most of California that has heavy air conditioning loads, electric heat in San Francisco causes an electrical usage "peak" during cold winter weather that strains local generation and distribution capacities.

KEY CONCEPTS IN AFFORDABLE HOUSING

This Handbook stresses four key concepts: Durability (and ease of maintenance), Energy Efficiency, Indoor Air Quality, and Recycling. The first two concepts help to insure that housing remains high quality and affordable over the long term. The third key concept, Indoor Air Quality ("IAQ"), is intended to insure that housing is healthy, particularly for people with respiratory problems, such as asthma. The last key concept, Recycling, is very broad, combining everything from "recycling" entire buildings (rehabilitation, or "rehab"), to using building materials that contain recycled materials.

This section will address the following issues:

A. Durability and Ease of Maintenance

B. Energy Efficiency

C. Indoor Air Quality ("IAQ")

D. Recycling

Durability and Ease of Maintenance

Durability may be the single most important concept for insuring that housing remains healthy, high-quality and affordable for the long term. Intensely used housing, like Single Room Occupancy (SRO) hotels or multifamily rental housing, requires durable materials to stand up to heavy use. Finishes and fixtures commonly found in market rate housing often cannot withstand the demands of high use, high density, affordable housing. In addition, the neighborhoods in which affordable housing is located, or the populations it is designed to serve, sometimes present challenges not typically found in market rate housing.

Finishes chosen for low initial cost without sufficient consideration of long-term maintenance needs may require frequent replacement and repair and thus greatly increase operating costs. If durability is sacrificed, the burden of avoidable repairs can cause a building to begin a downward spiral where deferred maintenance leads to increased tenant vacancies that further compound cash flow problems. Without an infusion of additional funds, this spiral can have catastrophic consequences. Therefore, durability is not a luxury, but a crucial part of the initial investment that helps to maintain affordability by reducing pressure on a building's operating and replacement reserves.

Durability is an important concept in green design because durable building components last longer and therefore generate less waste that needs to be disposed of in our landfills. Durability also provides significant, though less obvious, benefits by insulating tenants from unnecessary replacement and repairs performed in an occupied building. For example, carpet removal can generate a tremendous amount of dust. Even in newer buildings this dust can contain mold, dust mites, and other asthma triggers. In older buildings the dust may also contain hazardous levels of lead.[1] In addition, new carpeting may "offgas"

volatile organic chemicals ("VOCs") that can create health problems for people with chemical sensitivities.[2] Therefore, a decision to use a more durable floor covering can improve a building's operating budget, save precious landfill space, and protect indoor air quality.

Although durability is an important consideration, things eventually wear out and break. Some property managers prefer components that are either "'bombproof' or easily replaceable." This means things should either be extremely durable, or easy to fix and replace. In order to be easily replaceable, replacement parts should be locally available, and maintenance or repair should not require highly specialized skills. Otherwise, a component may be rendered unusable due to a lack of readily available replacement parts or skilled labor.

Energy Efficiency

Energy efficiency can provide significant financial benefits to the residents, managers and owners of affordable housing. Not only has California's recent energy crisis and rising energy costs necessitated a change in energy use on the part of the general population, but housing developers and property management firms have had to review and adjust proformas and operating budgets to take into account rising energy costs. Methods for saving energy have the potential to offer considerable financial savings that help to preserve affordability. Life-cycle cost analysis (introduced above) of energy efficiency measures can be used to evaluate whether financial savings generated over time justify higher up front costs. In addition, lower energy costs can directly translate into lower operating costs, and the savings may be used to help leverage additional financing for the project.

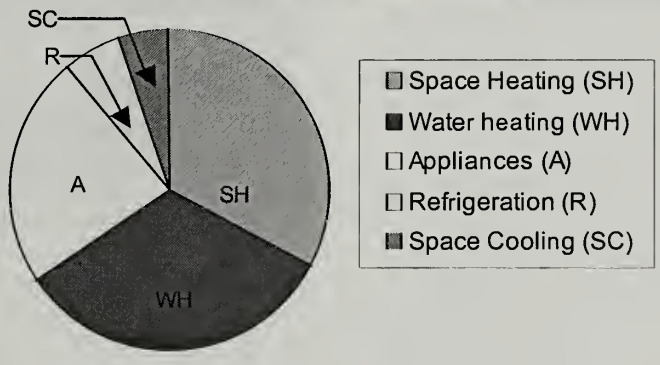
Decisions made early in the design will impact energy use throughout the life of a building. The basic design of the building envelope has a substantial impact on the building's energy use. For example, access to natural light and air on at least two sides of units provides opportunities for "daylighting"[3] and cross ventilation.[4] This in turn will reduce the need for artificial light and mechanical ventilation, thereby lowering energy consumption and utility bills. Another example of how early design decisions can impact energy use is the space allocated to heating systems. If adequate space is not provided in the initial ("schematic") design for an energy efficient boiler or furnace, then it can be very difficult later in the project to incorporate these essential features.[5]

Although developers may not have the time or expertise to analyze different energy efficiency scenarios, there are growing sources of energy information, software and consultants. For example, many affordable housing projects already use consultants to provide sophisticated energy use analyses to "model" buildings when a design does not meet the prescriptive energy standards of the Code. These same consultants can also be used to increase energy efficiency beyond the Code-required minimum in ways that can be justified through life cycle costs.

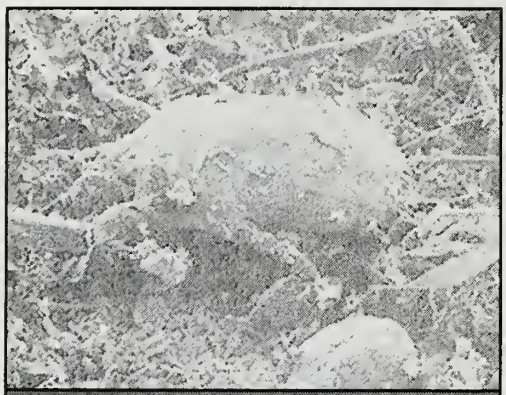
New energy efficient buildings have vastly lowered utility costs when compared to older, existing buildings. Some local Housing Authorities have recognized this distinction by establishing alternative utility allowances that more accurately reflect the actual energy usage of efficient buildings. In addition, on a project-by-project basis, the California Tax Credit Allocation Committee ("TCAC") regulations allow the use of an alternate utility allowance if the local utility company certifies projected utility costs for the building. To secure this certification, the sponsor's engineers must first calculate projected unit energy costs and determine if they are substantially lower than the standard utility allowance. The local utility company must review and certify the calculations presented by the sponsor's engineers. In addition, according to current TCAC regulations, the local utility must re-certify the alternative utility schedule annually. Although it may be difficult to establish an alternative utility allowance, the benefits can be significant. With a lower and more accurate utility allowance, the project may be able to leverage more financing, thereby improving project feasibility.

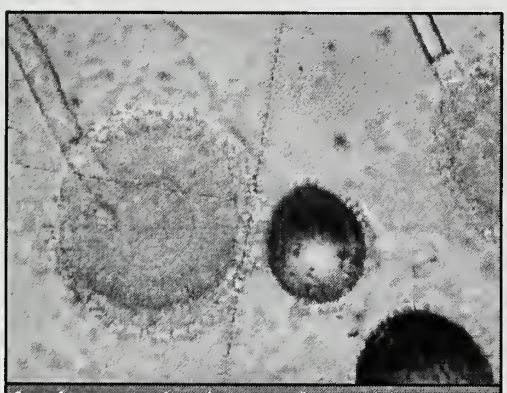
Four factors drive demand for energy use in a typical San Francisco residence: space heating, refrigeration, plug loads (such as lighting and small appliances), and water heating. Many of these issues can be addressed, and energy use minimized, through the installation of energy efficient equipment, windows, appliances and light fixtures. Look for the Energy Star label to maximize energy efficiency.

Energy Use in Multifamily Buildings



Dept. of Energy Building Technologies ProgramMultifamily Best Practices
Office of Energy Efficiency & Renewable Energy
(*www.eere.energy.gov*).


A microscopic picture of a dust mite


A microscopic picture of a mold spore

Indoor Air Quality

Indoor Air Quality ("IAQ") refers to air pollution inside a building. IAQ is important because the air inside a building is frequently far more polluted than the air outside.[6] Since people spend a great deal of time indoors, the negative health impacts of poor IAQ can be significant. Although no simple formulas exist for calculating the financial benefit of improving residential IAQ,[7] cleaner indoor air promotes healthier housing.

The types of indoor air pollution that can be controlled through thoughtful design and careful construction can be separated into three basic categories: **Dust, Mold** and **Gases**. All three have been identified as asthma triggers. Asthma is a growing problem, particularly among low-income inner city children.[8] In order to control asthma, it is important to minimize the amount of pollutants within a building. Fortunately, there are a number of rather simple and effective strategies that can be used to minimize indoor air pollutants, and thereby improve the health of all residents, especially those living with asthma or other respiratory diseases.

Dust ("respirable particulates") is perhaps the most common indoor air pollutant. It can be responsible for eye, nose and throat irritation, increased susceptibility to respiratory infections, bronchitis, and asthma. A simple, inexpensive first step to help control dust is to provide removable floor mats at the main entry to the building to reduce the amount of outdoor contaminants that are tracked inside.[9]

In general, hard, easily cleanable floor surfaces, such as linoleum, should be used wherever possible.[10] Simply put, carpeting can become a "dust magnet" that is very difficult to clean adequately. In addition, if carpeting gets wet, it may quickly become a breeding ground for mold and mildew.[11] Even vacuuming carpeting is considered to be an asthma trigger.[12]

Perhaps surprisingly, cockroaches have been identified as a significant asthma trigger for many people.[13] Fortunately, proper design and construction can help to exclude cockroaches, thereby improving IAQ and reducing the need for toxic pesticides within tenants' homes. Cracks 1/16" and larger, particularly around cabinets and baseboards, should be caulked. Penetrations for plumbing pipes and electrical conduit should be covered and sealed.[14] As an added benefit, these measures can also be helpful in excluding mice, rats,[15] and to a limited degree, even bedbugs.[16]

Another significant, preventable, asthma trigger is the dust that is created in an occupied building during rehabilitation. It is extremely important to prevent the uncontrolled migration of dust outside of a work area, because even "benign" dust can cause respiratory problems and trigger asthma. Therefore, dust containment (or "engineering controls"), safe work practices that reduce the amount of dust generated (such as "wet methods"), and regular clean-up (preferably with vacuums using HEPA filters) are important to help to maintain healthy IAQ during occupied rehabs.[17]

Ways to reduce dust...

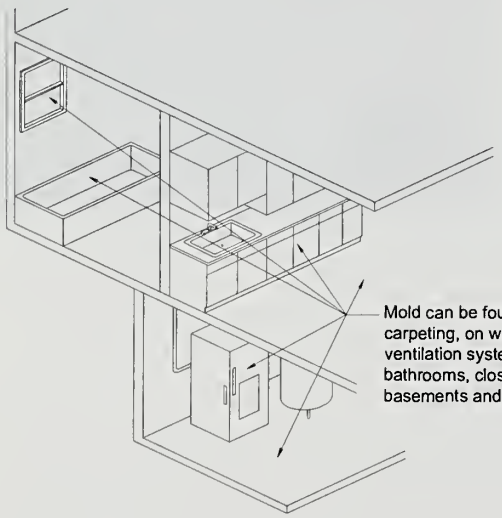
✓ Specify hard, cleanable floor surfaces, such as linoleum, wherever possible.

✓ Vaccum regularly (preferably using HEPA filters) to help maintain healthy IAQ during occupied rehabs.

✓ Provide removable floor mats at the main entry to the building to reduce the amount of outdoor contaminants that are tracked inside.

Mold and other biological agents such as dust mites can also trigger asthma and allergic reactions.[18] In order to control mold and dust mites, it is necessary to control water and indoor humidity.[19] The building envelope (roof and exterior walls), plumbing systems and HVAC systems must be properly designed, constructed and maintained to prevent leaks and control humidity. As an added benefit, proper design, construction and maintenance help prevent "dryrot" in wooden framing, thereby avoiding expensive, and avoidable, structural repairs in the future.

Adequate ventilation, particularly to exhaust moisture/steam from cooking and bathing, is essential for controlling mold. In general, ducted exhaust fans should be provided in the kitchen and bathroom to remove excess moisture from the air.[20] Quiet fans are more likely to be used than noisy fans.[21] In addition, adequately sized operable windows are an excellent, time-tested, energy efficient means that can assist with the elimination of excess moisture and indoor air pollutants.



Mold can be found in the carpeting, on windows, in ventilation systems, kitchens, bathrooms, closets, ceilings, basements and moist areas.

Even the condensation that forms on the interior surface of single-paned windows or on aluminum window frames can provide sufficient moisture for mold and mildew to grow. Dual glazed windows typically prevent this problem in San Francisco's moderate climates.[22] In addition, dual glazed windows improve energy efficiency and decrease thermal differentials within a room, thereby making the space feel "more comfortable."

If mold or mildew is encountered, it is important to determine the source of the moisture that is causing the problem. If the moisture is not eliminated, then the mold or mildew will simply return, regardless of the amount of cleaning. The cleaning of moldy or mildewed items should be performed in a safe fashion to prevent contaminating workers, tenants, or other areas of the building.[23]

Ways to reduce exposure to molds...

✓ Prevent water leaks and moisture intrusion through proper detailing and maintenance of the building envelope.

✓ Provide adequate ventilation through the provision of operable windows and ducted exhaust fans in the bathroom and kitchen.

✓ Specify dual glazed windows to limit condensation (and increase overall energy efficiency and comfort!).

Gases (including volatile organic chemicals, or "VOCs") are the third major source of indoor air pollution that can be reduced through careful design and construction. Gases can cause a myriad of health problems, including asthma, headaches, and even lung damage.[24] Some gases are invisible and odorless, and therefore difficult to detect.

Cooking and oven cleaning have been identified as activities that can cause unhealthy indoor air, generating high levels of nitrogen dioxide and formaldehyde.[25] Fortunately, a good, ducted kitchen exhaust fan can remove these pollutants from a unit, and thereby improve IAQ. In addition, all gas appliances and heaters need to be properly installed and maintained to prevent the build-up of unhealthy levels of carbon monoxide within a unit.[26]

Many building materials, including paint, composite wood products (such as particleboard and plywood), adhesives, and carpeting, may contain VOCs that can "off-gas" at normal temperatures.[27] For example, the adhesives used in composite wood products often contain urea-formaldehyde resins. Formaldehyde is a VOC that has been identified as a toxic air contaminant and carcinogen.[28] Individuals vary widely in their sensitivity to VOCs such as formaldehyde.[29]

Project managers seeking to reduce off-gassing can select low VOC, or VOC-free paints, adhesives, carpeting, and composite wood products such as medium density fiberboard ("MDF") with no added formaldehyde. In addition, all plywood, particle board, or MDF with added formaldehyde should be sealed, painted or covered with a laminate to minimize off-gassing. Also, the sequencing of construction can be scheduled so that soft finishes (such as carpeting) that can absorb, and then re-emit VOCs, are installed after high emissions work (such as painting) is completed.[30] Finally, it is important to involve property management and tenants in all efforts to control VOCs because cleaning supplies and personal hygiene products have been identified as a significant source of air pollution.[31]

Ways to reduce exposure to gases...

- ✓ Install a good, ducted kitchen exhaust fan.
- ✓ Properly install and maintain gas appliances and heaters.
- ✓ Select low VOC or VOC-free paints, adhesives and carpeting during construction.
- ✓ Seal, paint or cover all plywood, particle board or medium-density fiberboard.
- ✓ Control VOCs that come from cleaning supplies and personal hygiene products used by tenants and property management.

Recycling

Anyone who sets aside cans, bottles, and newspapers for curb-side pick-up is familiar with the concept of recycling. San Francisco recently met the state mandated waste management goal of diverting at least 50% of all waste from landfills.[32] However, San Francisco has "upped the ante" by establishing a goal of diverting 75% of all waste from landfills by 2010.[33] Therefore, affordable housing needs to provide adequate space within units and within buildings for recycling. In order to meet the 75% recycling goal, buildings should typically provide two to three times the space for recycling that is provided for trash.[34] Recycling, however, can also be pursued at a much larger scale - the scale of land development - with the benefit of keeping thousands of tons of waste out of landfills.

Rehabilitation ("Rehab"). The most important and beneficial form of recycling is to reuse entire structures. Rehabilitation projects are inherently green in this respect because they can save tremendous amounts of resources when compared to new construction.[35]

Recycled Content: What does it mean?

The term "recycled content" typically refers to both "post consumer material" and "secondary" material. Post consumer material comes from products which were purchased by consumers, used, and then discarded (recycled). For example, a newspaper which has been read, recycled, and then used as base material for new paper products, is an example of post consumer recycled material.

Secondary material, also called "preconsumer" or "postindustrial", consists of material waste produced during the manufacturing process itself, which is then recaptured and used as base material for new products. Scraps of carpet trimmed from finished rolls in the manufacturing plant which are then used as base material for production of new carpet fibers is an example of secondary recycled content.

Source: Recycled Content Product Database, sponsored by the California Integrated Waste Management Board. *www.ciwmb.ca.gov/rcp.*

Deconstruction (or "salvage") recognizes that old buildings may contain valuable materials that can be reused. For example, the lumber used in older buildings is often of much higher quality than most new lumber available today.[36] Deconstruction works best when an experienced deconstruction contractor begins working with the project team long before the time when demolition is scheduled to begin. Since deconstruction is typically more labor intensive than traditional demolition, it can be more costly. However, these costs can be controlled if a market is identified in advance for the materials that will be removed from an existing building. For example, old growth structural lumber can be removed/deconstructed from an existing building prior to demolition. The old growth lumber can then be re-milled and reused as finished flooring in the new affordable housing that will be constructed on the site. In addition, deconstruction can provide an excellent vehicle for promoting hiring programs designed to provide employment opportunities for low-income neighborhood residents.[37]

Construction and demolition debris. According to the California Integrated Waste Management Board, 12% of California's waste is generated from construction and demolition ("C&D").[38] Project managers can encourage C&D recycling by including Waste Management Plans with recycling requirements in their specifications.[39] In addition, builders experienced with C&D recycling can use their expertise to differentiate themselves from other builders, and thereby increase their market share.[40]

Materials with recycled content. The value and ease of recycling grows as the demand for products with recycled content grows. Projects that specify materials that include a percentage of post consumer waste product help to limit the extraction of new natural resources and encourage the growth of markets for recycled products. For example, some carpet is now made from 100% recycled plastic bottles.[41]

1 For further information regarding lead, see HUD's "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing" available at www.hud.gov/offices/lead/guidelines/hudguidelines/index.cfm.

2 The Carpet and Rug Institute ("CRI") has established a "Green Label" testing program to identify carpet products that are truly low VOC. See, *www.carpet-rug.com/drill_down_2.cfm?page=8&sub=6.*

3 Daylighting uses natural sunlight to light a building's interior. See, US Dept. of Energy, Energy Efficiency and Renewable Energy ("EERE"), "Passive Solar Heating, Cooling and Daylighting." *www.eere.energy.gov/RE/solar_passive.html.*

4 "Natural ventilation through operable windows can be an effective and energy-efficient way to supplement HVAC systems to provide outside air ventilation, cooling, and thermal comfort when conditions permit (e.g., temperature, humidity, outdoor air pollution levels, precipitation)." See, "IAQ Design for Schools: HVAC Systems - Potential for Natural Ventilation and Operable Windows," EPA, *www.epa.gov/iaq/schooldesign/hvac.html.*

5 When feasible, projects funded in whole or in part by the San Francisco Mayor's Office of Housing ("MOH") must provide adequate space for an energy efficient furnace and boiler in the schematic design phase.

6 "Indoor Air Pollution: A Serious Health Problem," California Air Resources Board, May 2, 2001, *www.arb.ca.gov/research/indoor/rediap.htm.*

7 By contrast, businesses have documented productivity gains of up to 16% after undertaking green measures. Romm, Joseph and Browning, William, "Greening the Building and the Bottom Line: Increasing Productivity Through Energy Efficient Design," (Rev. 1998), Rocky Mountain Institute, *www.rmi.org/images/other/GDS-GBBL.pdf.*

8 Eleven percent of the children in the U.S. have asthma, more than double the number in 1980. EPA, "IAQ Tools for Schools Vol. 3," www.epa.gov/iaq/schools. Asthma is the number one cause of hospitalization among children under the age of 15. American Lung Assoc., "Asthma in Children Fact Sheet," www.lungusa.org/asthma. Children from poor neighborhoods are far more likely to be hospitalized for asthma than are children from better-off neighborhoods. "Asthma hits children hardest in poor neighborhoods," Reuters Health, 7/27/99, *www.calnurse.org/can/new1/Post672899.html.* Nearly 500,000 Americans are hospitalized annually and more than 5,000 die annually of asthma. "Asthma," *www.MayoClinic.com.*

9 Floor mats should be designed and maintained to avoid creating a trip hazard. It may be appropriate to design the floor covering so that there is a "recess" within which a standard sized mat fits.

10 Although this discussion is geared toward an analysis of health issues, since hard surfaces are typically more durable than carpeting, they can also provide excellent value over time.

11 "If a carpet becomes wet and is not dried thoroughly within 24 hours, it can support mold and mildew." The first step is to determine the source of the water. "Only carpet damaged by sanitary water can be treated non-professionally." HUD Rehab Guide Vol. 5 (2/2000), "Partitions, Ceilings, Floors & Stairs", pg. 37.
www.huduser.org/publications/destech/rehabbds.html.

12 The American Lung Association ("ALA") recommends against vacuuming when people with asthma are present. In addition, the ALA suggests that "if vacuuming must be done, a dust mask may help." See, "Controlling Asthma Triggers," 2/2000.
www.lungusa.org/air/air00_triggers.html.

13 Cockroach droppings or body parts are a recognized asthma trigger for many people. Indoor Air - Asthma, "Asthma Triggers - Cockroaches", EPA, *www.epa.gov/iaq/asthma/triggers/pests.html.*

14 Pest Notes Publication 7467, "Cockroaches," University of California Division of Agriculture and Natural Resources, Nov. 1999, *www.ipm.ucdavis.edu.*

15 "Doctors Now Blame Mice For Asthma in Urban Areas," San Francisco Chronicle, 12/12/2000. Pest Notes Publication 7483, "House Mouse," University of California Division of Agriculture and Natural Resources, Nov. 2000. Pest Notes Publication 74106, "Rats," University of California Division of Agriculture and Natural Resources, Jan. 2003. www.ipm.ucdavis.edu.

16 Pest Notes Publication 7454, "Bedbugs," University of California Division of Agriculture and Natural Resources, Rev. Sept. 2002. *www.ipm.ucdavis.edu.*

17 An excellent description of engineering controls, safe work practices and clean-up can be found in HUD's "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing" available at www.hud.gov/offices/lead/guidelines/hudguidelines/index.cfm. When the guidelines are followed even when lead is not present, then the occupants should be protected from the hazards of dust inside a building during an occupied rehab.

18 "Indoor Air Pollution: A Serious Health Problem," California Air Resources Board, May 2, 2001,
www.arb.ca.gov/research/indoor/rediap.htm.

19 "A Brief Guide to Mold, Moisture, and Your Home," EPA, *www.epa.gov/iaq/molds.*

20 "Sources of Indoor Air Pollution - Biological Pollutants", EPA, www.epa.gov/iaq/biologic, "Install and use exhaust fans that are vented to the outdoors in the kitchen and bathrooms and vent clothes dryers outdoors ... [to] eliminate much of the moisture that builds up from everyday activities."

21 Effectiveness of bath exhaust fans may be improved even further by the use of timers directly wired to a light switch so that the fan operates for a predetermined period of time each time the light is switched on.

22 If aluminum frames are used, the high thermal conductivity of aluminum can cause condensation to form on the frames. This problem can be eliminated by using aluminum frames with a thermal break.

23 When cleaning mold, use a dust mask and good ventilation. Clean with detergent followed by a 10% bleach formula (1 ½ cup bleach per gallon of water). For further information see, "Guidelines for Mold Control," San Francisco Public Health/Environmental Health (415.252-3800). In addition, "Mold in My Home: What Do I Do?" California Dept. of Health Services, www.cal-iaq.org/mold0107.htm, and "A Brief Guide to Mold, Moisture, and Your Home," EPA, *www.epa.gov/iaq/molds/moldguide.html.*

24 "ARB Fact Sheet: Air Pollution Sources, Effects and Control," California Air Resources Board, October 29, 2001,
www.arb.ca.gov/research/health/fs/fs2/fs2.htm.

25 "Advisory: Cooking Activities Cause Unhealthy Indoor Air", California Environmental Protection Agency News Release, November 21, 2002, *www.arb.ca.gov/newsrel/nr112102.htm.*

26 "Protect Yourself and Your Family from Carbon Monoxide Poisoning", EPA (10/96), *www.epa.gov/iaq/pubs/coftsht.html.*

27 "Off-gassing" occurs because some building materials "can contain contaminants that are gradually emitted (off-gassed) throughout the life of the material." See, "IAQ Design Tools for Schools: Controlling Pollutants and Sources", EPA
www.epa.gov/iaq/schooldesign/controlling.html.

28 "Fact Sheet: Composite Wood Products," California Air Resources Board, *www.arb.ca.gov/toxics/toxics.htm.*

29 "Some people are not bothered by moderate levels, while others are affected by low levels." Formaldehyde in the Home, California Air Resources Board, September, 1991,
www.arb.ca.gov/research/indoor/formald.htm.

30 "IAQ is affected not only by the materials that are used but also by the order in which they are installed.... Contaminants off-gassed by ... materials can be absorbed by 'fuzzy' or 'fleecy' materials ... [that] can become repositories (often referred to as 'sinks') for substances that can be released much later..." See, "IAQ Design Tools for Schools: Controlling Pollutants and Sources," EPA *www.epa.gov/iaq/schooldesign/controlling.html.*

31 "Ordinary household products such as cleansers, cosmetics and paints are now the Los Angeles region's second leading source of air pollution," Chemicals in Home a Big Smog Source, LA Times, March 9, 2003, *www.latimes.com.*

32 "San Francisco Recycles More than it Throws Away," SF Environment, *www.sfgov.org/sfenvironment/articles_pr/2002/pr/121202.htm.*

33 "SF seeks to recycle 75% by 2010," SF Environment, *www.sfgov.org/sfenvironment/articles_pr/2002/article/100102.htm.*

34 In general, the total amount of space devoted to household waste facilities should not have to increase in order to provide adequate space for collecting recycling and compostables. Rather, the space dedicated to household waste needs to be flexible to accommodate waste diversion strategies which today include separate bins for trash, recycling and compost. Of course, the smaller the unit, the less likely it is that there will be adequate space within the unit itself for separating waste.

35 The LEED Green Building Rating System recognizes the inherent sustainability of rehab by providing a "Materials and Resources" credit for "Building Reuse" because it conserves resources, retains cultural resources, reduces waste and reduces environmental impacts of new buildings as they relate to materials manufacturing and transport. *www.usgbc.org/Docs/LEEDdocs/LEED_RS_v2-1.pdf.*

36 Structural lumber typically needs to be certified. Therefore, most lumber reclaimed through deconstruction is ultimately used as finish materials, in order to avoid the need to undergo costly structural certification.

37 "A Guide to Deconstruction: An Overview of Deconstruction with a Focus on Community Development Opportunities", HUD Office of Policy Development and Research, NAHB Research Center (February, 2000).

38 "Sampling of solid waste disposed in California for the year 1999 indicated that 12 percent of the material disposed was classified as C&D materials," See, "Construction and Demolition Debris Recycling," *www.ciwmb.ca.gov/ConDemo/ .*

39 Due to extremely limited space on most urban construction sites, project managers should work with their contractors to fashion project specific Waste Management Plans that establish achievable goals. In San Francisco, C&D recovery rates are now commonly in the 65% range, even when the contractor is not engaging in any construction site recycling or sorting.

40 See, "Case Study: New Construction Recycling - Citation Homes Recycles 86% of New Construction Waste," *www.stopwaste.org/citation.html.*

41 Green Resource Center, "'Greener' Carpet", (Rev. 11/11/02), *www.greenresourcecenter.org/MaterialsSheets/GreenerCarpet.html.*

CHALLENGES IN AFFORDABLE HOUSING

No project is perfect. Challenges are inevitable. Perhaps no challenge is greater than the fact that funding for affordable housing is extremely limited. Furthermore, the initial construction cost for projects that are designed to be durable and energy efficient, with good indoor air quality, and that promote recycling may not compare favorably to other projects that do not incorporate those features. In addition, affordable housing developers seeking to include new or different construction materials may be faced with resistance from the builder, especially if the sponsor is directing the builder to perform the work in a way that varies from standard construction practices. Finally, several issues concerning the rehabilitation of existing buildings ("rehabs"), with a special emphasis on occupied rehabs, are considered.

This section will address the following issues:

A. Funding for Sustainable Buildings

B. Comparing Initial Costs to Other Buildings

C. Changing Standard Construction Practices

D. Rehabilitation of Existing Buildings

Funding for Sustainable Buildings

Although limited, there is an assortment of programs that can help fund some green features of a development, including the Federal Low Income Housing Tax Credit Program, the California Energy Commission's Emerging Renewable Program for Affordable Housing, local utility rebates and incentive programs, and some foundations. These programs can complement each other. For example, PG&E's multifamily ENERGY STAR Homes Program will fund 3rd party energy consultants that can provide the technical expertise needed to achieve the common goals of exceeding Title 24 requirements under all three programs.

Tax Credit Program

The California Tax Credit Allocation Committee (TCAC), which administers the Federal Low Income Housing Tax Credit Program, promotes sustainable building through both application scoring and through an increase in the threshold basis limits[1] to help pay for the additional initial cost of certain items.

Application Scoring. In 2003, the TCAC application scoring allows up to 8 points for a variety of sustainable building methods. The applicant and project architect must certify in the application and at the project's placed-in-service date that the items have been included. The first five points are for a project application that utilizes materials that will increase energy efficiency by at least 15% above Title 24 energy standards, or a rehabilitation project that will increase its existing energy efficiency by at least 25%.

TCAC Application Scoring...

Projects that incorporate items from the following list may receive an additional 1 point for each, to a maximum of 3 points:

✓ Use of energy efficient appliances with the Energy Star rating for all appliances and for all heating and cooling systems

✓ Use of natural gas for cooking and space heating

✓ Use of occupancy sensors for all bathrooms, garages and storage spaces

✓ Use of florescent light fixtures for at least 75% of light fixtures

✓ Use of simple, low water landscape or irrigation design that reduces water use by a minimum of 10% over conventional irrigation designs

✓ Use of formaldehyde free or fully sealed particleboard or fiberboard for all cabinets, countertops and shelving

Increase in threshold basis limits. In 2003, the tax credit program provides a 4% increase in the threshold basis limits for projects that include three of specified energy efficiency/resource conservation/indoor air quality items. This basis boost can increase capital contributions to the project to help pay for these items.

A further increase in basis limits up to 5% is allowed in projects where distributive energy technologies such as microturbines and/or renewable energy sources such as solar will be implemented. To obtain this increase, the applicant must submit evidence of the savings to be created through the use of the technology, and is permitted in the Executive Director's sole discretion.[2]

To illustrate the potential equity value of the TCAC increase in basis limits for sustainable development items, the following is a calculation of tax credits for a hypothetical project that has incorporated energy efficiency items and a renewable energy source, such as solar (photovoltaic) power. The combined energy efficiency and renewable energy basis boost value for this project with a $10 million basis limit is $786,512.

Calculation of Tax Credits and Value of Equity...

Sample Project with Improved Energy Efficiency and Renewable Energy

Project Assumptions:

1). 9% Federal Credits (not tax-exempt bonds)
2). Eligible costs exceed basis limits ("basis limited project")
3). Basis limit is a "plugged" figure of $10M
4). Savings generated by renewable energy source exceed $500,000 over 55 years
5). Title 24 exceeded by 15%
6). Energy efficiency/resource conservation/indoor air quality items: see *Page 40 of Regs.*

(1) Exceed Title 24 standards by at least 20%
(2) Use Energy Star rated appliances — *Selected*
(3) Use gas ovens, stoves, and clothes dryers
(4) Use tankless water heaters — Must select 3
(5) Use linoleum or ceramic tile for kitch/baths
(6) Use natural fiber, recycled content flooring — *Selected*
(7) Use Energy Star rated roofs
(8) Provide hard wiring for computers in units — *Selected*

Basis Calculation		
221(d)(3) Basis Limit		$10,000,000
TCAC Basis Limit (before adjustments)		**$10,000,000**
Plus Prevailing Wage Adjustment	12%	$1,200,000
Plus Special Needs Adjustment	2%	$ -
Plus Energy Efficiency/Resource Conservation	4%	$400,000
Plus Renewable Energy Boost*	5%	$500,000
Totals		**$12,100,000**
High Cost Adjustment	**130%**	**yes**
Qualified Credit Basis		**$15,730,000**
Federal Credit Rate for a 9% project	**8.10%**	
Max Credit Amount		**$1,274,130**
Ten Year Total		**$12,741,300**
General Partner Share	*0.01%*	$1,274
Limited Partner Share	*99.99%*	$12,740,026
Tax Credit Factor	*$0.83*	
Total Tax Credit Equity		**$10,574,221**

Equity Value of Energy Boosts	Boost Value	Equity Value
Energy Efficiency	$400,000	$349,561
Renewable Energy	$500,000	$436,951
TOTAL PROJECTED EQUITY VALUE FOR ENERGY BOOSTS		**$786,512**

*Calculation of the boost is based upon the lesser of 5% or estimated savings to the project over 55 years.

California Energy Commission's Emerging Renewable Program for Affordable Housing

In 2002, the California Energy Commission established a rebate for photovoltaic (PV) systems installed on affordable housing projects, which can reduce the price significantly. PV converts sunlight directly into electricity using semi-conductors, often incorporated into panels mounted on the roof. Affordable housing projects may qualify for an extra 25% rebate above the standard rebate, not to exceed 75% of the system cost based on meeting additional eligibility criteria. This rebate can supplement the tax credit program basis boost to help pay for the installation of solar electric systems. The project must be individually metered, and funding levels decrease every 6 months.[3]

Local utility rebates and incentive programs

As of 2003, energy efficiency rebates and incentive programs for multifamily housing are available statewide. PG&E's ENERGY STAR Homes Program offers up to $150 per multifamily unit for projects that incorporate energy efficient features. To qualify, buildings must be accepted into the program before beginning construction and exceed Title 24 requirements by at least 15%. This program is for new construction, and the project must be in the PG&E service territory. PG&E will provide program support, including additional incentives for multifamily energy consultants and inspections.[4]

While the requirements of funding programs may change from year to year and take time to research and assemble, they can make a critical difference. Incorporation of sustainable building methods into the tax credit program scoring will ultimately raise the bar for certain green building features to become standard in affordable housing.

Foundation Support

The Kresge Foundation, as part of its Green Building Initiative, is providing special planning grants of $50,000 to $100,000 to nonprofits to help cover costs associated with investigating sustainable building design, as well as bonus grants of $150,000 - $250,000 to grantees whose buildings become Leadership in Energy and Environmental Design ("LEED") certified. They will hold green building workshops designed for nonprofit organizations in 2004, and have developed two brochures for non-profits: "Why Build Green?" and "How do I Build Green?" which can be downloaded from www.kresge.org/initiatives/index.htm.

Groups that can provide technical assistance and up-to-date information on sustainable development funding sources...

✓ Green Affordable Housing Coalition. (*www.greenaffordablehousing.org*)

✓ Global Green's Greening Affordable Housing Initiative. (*www.globalgreen.org*)

✓ The Department of Energy's Rebuild America Program. (*www.rebuild.org*)

✓ Twin Pines Cooperative Foundation, "Photovoltaics for Affordable and Cooperative Housing," April 2003. See *www.dcn.davis.ca.us/go/actpcoop* or email verve@dcn.org.

✓ Energy Action. (www.energyactionresources.org)

Comparing Initial Costs to Other Buildings

Affordable housing developers frequently struggle to reduce initial costs to protect a project's comparability to other affordable housing projects. A variety of project-specific issues can drive up construction costs, including unusual site conditions (such as steep slopes or poor soil), neighborhood opposition (generating expensive design features or lowered density), and special needs of the tenant population. These issues may make a project appear unusually expensive when compared to other affordable housing developments. Therefore, it is important to highlight any elements that distinguish one project from others. For example, a design that promotes energy efficiency may have somewhat higher initial costs than a similar project that simply meets Code minimum energy requirements. However, if the higher initial costs can be supported by life cycle cost analyses that demonstrate savings over time, then the higher initial costs actually advance long term affordability. By highlighting the long term savings that differentiate a project from otherwise comparable projects, developers can help to justify higher initial costs that promote healthy, high quality, affordable housing.

Changing Standard Construction Practices

Though much of what comprises green building is really just good design and construction,[5] some green building products and techniques are relatively new. There is always an element of risk when a new procedure is used because, like many things, much of construction is based on habit. Contractors frequently build as they always have. However, when good products are installed incorrectly, they do not perform to their potential and the value of their inclusion in the project is lost. Therefore, in order for green building materials, assemblies and equipment to be correctly installed, the developer should pay careful attention each step of the way.

- ☐ The specification should clearly highlight green measures.
- ☐ Installers should have experience with the materials or techniques.
- ☐ The owner, architect and contractor should collectively review the materials and equipment, installation procedures and potential schedule impacts of green measures prior to the start of construction, and again regularly during the course of construction.

Rehabilitation of Existing Buildings ("Rehab")

Rehab is inherently green because the recycling and reuse of entire buildings eliminates the need to dispose entire buildings. Rehab is inherently affordable because the cost of preserving an existing structure is frequently lower than the cost of new construction. In addition, rehabilitation of older buildings can help to preserve the historical character of a neighborhood. Rehab projects, however, can present a unique set of problems, including unforeseen conditions, code issues involving existing conditions, and working in occupied buildings.

Unforeseen conditions are issues that arise during construction that were unknown when the construction started. Unfortunately, what you don't know *can* hurt you. Delays and cost overruns cased by unforeseen conditions are the bane of rehab projects. Commonly encountered unforeseen conditions include: dry rotted and deficient structural framing, overloaded electrical systems, and deteriorated plumbing or steam pipes. When these issues arise after construction has started, the owner may need to make critical decisions in a very short time, frequently at non-competitive prices.[6] Fortunately, developers can help to minimize unforeseen conditions by insuring that design assumptions are made explicit, and by verifying the accuracy of the assumptions prior to bidding the work.

The three most important resources for verifying design assumptions are: **maintenance staff expertise, exploratory demolition, field measurements** and **systems testing**.

- ☐ The ideal situation is when an owner is seeking to rehab a building that they have been managing for a year or more. In this situation, the project manager can work closely with **maintenance staff** and benefit from their experience. A careful review of maintenance work orders combined with in-depth discussions with maintenance staff can reveal many of a building's deficiencies. Special attention should be paid to patterns of problems. The information should be summarized and shared with the project team in order to develop a plan for exploratory demolition and systems testing.

- ☐ **Exploratory demolition** simply means the removal of portions of a building's fixtures and finishes in selected areas prior to the rehab in order to be able to visually inspect typical conditions otherwise hidden behind walls, ceilings and floors. Exploratory demolition can be particularly useful to discover dry rot and plumbing problems in bathrooms and kitchens. After the finish surfaces have been removed, the project team should carefully inspect and document the results of the survey. Temporary coverings should be placed over the uncovered areas for safety and to maintain barriers that exclude pests, such as cockroaches. Caution must be used to avoid damaging plumbing pipes or electrical wires. In addition, dust control measures should be implemented to protect the health of workers and tenants.

- **Field Measurements.** "As built" drawings are supposed to show the actual dimensions of previous construction work. When available they can be a valuable tool to expedite rehab design. However, as-built drawings may contain significant errors. Therefore, critical dimensions should be verified by careful field measurements.

- **Systems testing** is generally proposed by an engineer in order to help determine the condition of an existing building system, such as pressure testing of plumbing or steam pipes. Project engineers should be queried very early in the design process to determine whether they have any recommendations for systems testing that could verify their assumptions regarding the condition of existing building systems.

Code issues involving existing conditions typically involve completed work that no longer meets the current Code. With some notable exceptions, work previously performed under a permit in conformance with Code in force at the time will be "grandfathered," and therefore does not need to be upgraded every time the Code changes.[7] However, rehab work often triggers significant mandatory Code upgrades, far beyond what the sponsor may wish to undertake. The rationale is that the appropriate time to bring a building up to current Code is when renovation work is being performed that may extend the useful life of the building. For example, proposed renovations to a unit bathroom to upgrade the toilet, sink and bathtub may trigger Code required upgrades to associated plumbing, structural, electrical, and even fire/life safety systems.[8] Sponsors may elect to schedule pre-permit application plan review meetings with the Building and Fire Departments to better understand how a particular rehab project will be required to address issues of accessibility, fire safety, seismic safety, building systems, etc. within the context of the planned scope and existing conditions.

Occupied rehabs are typically even more challenging, time consuming and expensive than rehabilitating a vacant building. For example, if tenants will need to move out of their units, even for a short period of time, an approved relocation plan is typically required. Relocation of tenants is a significant undertaking requiring an understanding of the applicable law and regulations, good communication and organizational skills, and a commitment of staff from pre-construction planning to final moves after construction completion.[9] At a bare minimum, the developer must insure that the building is safe and habitable during construction, tenants' privacy and security is protected, and tenants do not have to "come out of pocket" for any expenses related to the rehab.

Some issues that take on larger significance during occupied rehabs include: dust, lead-based paint, noise, safety, security, accessibility, and notice/utilities. In addition, the contractor will need adequate space for a job site office, deliveries, staging and storing materials, as well as access for moving personnel, materials and equipment through the building.[10] Perhaps most importantly, property management will have the challenge of operating a building under construction. When something goes wrong, the parties need to work together to quickly fix the problem, sometimes even before responsibility for the problem has been determined.[11]

- ☐ **Dust.** As noted in the IAQ section, even "benign" dust can trigger asthma or other pulmonary problems for people exposed to dust.[12] Ironically, work designed to improve IAQ, such as removing carpeting so that it can be replaced with hard surfaced flooring, can temporarily create dust hazards if the work is not performed carefully. Therefore, care must be used to insure that dust does not migrate in an uncontrolled fashion out of the work area. Measures include the installation and maintenance of plastic sheathing to contain dust, wet work methods to reduce the generation of dust, and frequent clean-up to collect and dispose of dust.

Considerations during occupied rehabs include maintaining...

- ✓ fire/life safety systems (alarms, sprinklers, smoke detectors, and exiting)
- ✓ accessibility
- ✓ security
- ✓ habitability (including dust, noise and vector control)
- ✓ utilities (electricity, water, heat, telephone, trash/recycling, cable, etc.)
- ✓ adequate space for a job site office, deliveries, staging and storing materials, as well as access for moving personnel, materials and equipment through the building

- **Lead based paint** is nearly ubiquitous in older buildings in San Francisco. In general, the mere presence of lead based paint in a building does not mean that there is a "lead hazard" that requires abatement by a specialty contractor. However, any work (even normal maintenance or "unit turnover" work by the owner's own staff) that will impact or disturb surfaces that may be coated with lead based paint requires planning, training and careful work practices to protect the health of tenants and workers.[13]
  - If the paint is in good condition, and it will not be damaged by construction, it can typically be safely maintained in place in accordance with an Operations and Maintenance Plan.
  - Each contractor impacting surfaces coated with lead based paint (such as demolition and painting subcontractors) needs training and State certification in order to perform the work safely.[14]
  - Developers working on rehab projects need lead expertise and certification on the project team (either in-house staff or an outside consultant) for inspection/risk assessment, final clearance, and on-going operations and maintenance.

- **Noise**. Unfortunately, some tasks, such as breaking up concrete, are inherently noisy. In occupied rehabs, it is important that the project manager understands the tasks and schedule well enough to communicate to tenants when the noisiest tasks will be taking place. In addition, the owner may want to impose some limits on the contractor's noise making activities. For example, in order to minimize disruption to tenants, the owner may wish to prohibit the noisiest construction activities from commencing prior to 8am or continuing after 6pm. However, overly restrictive limitations will tend to delay the work and drive up costs, so it is important to strive for a balance that gets the work done as quickly and efficiently as possible with a minimum of inconvenience to tenants.

- **Safety**. While safety is always a primary concern, the concern is heightened during an occupied rehab. For example, the simple act of removing sheetrock from a wall exposes structural wood framing to the risk of fire.[15] Similarly, a barricade erected for the protection of tenants to separate them from construction activities may have the unintended consequence of blocking an emergency exit in case of a fire. With proper planning and coordination with the Fire Department, these and other issues can be addressed to maximize safety during an occupied rehab. The Fire Department may require that fire sprinklers and alarms be active throughout the building during the entire course of construction, even if the original construction schedule called for this work to be performed at the end of the project.

- **Security**. The need for construction workers to access the building must be balanced with the need to prevent unauthorized people from entering the building. Project managers may elect to require all workers to sign-in when they enter or leave the building and to wear hardhats with stickers identifying them by name and the company they work for. In addition, prior to the start of construction, the sponsor must clearly establish and communicate any access restrictions. For example, workers should not be permitted to prop doors open, even for a short period of time, if by doing so it could allow an unauthorized person to gain access to the building. If a secured door, such as a door to the exterior, needs to be unlocked, there should be a worker stationed at the door at all times that it is unlocked.

- **Accessibility**. Maintaining accessibility for people with mobility impairments or with other disabilities can be extremely challenging during an occupied rehab. Special consideration is needed to insure that an accessible path of travel is maintained at the building entry, in common areas (including common bathrooms), and within units during construction. In the event that elevator service will be interrupted, the developer may need to temporarily relocate people who rely on the elevator, or to provide equivalent facilitation, such as delivering groceries or hand delivering mail during the time the elevator is inoperable.

- **Notice/Utilities.** Tenants are obviously entitled to advance notice before any construction worker enters their unit. In practice, contractors may not always understand that in order for the owner to provide 24 hour notice to tenants, the contractor must provide sufficient time for the owner to prepare and distribute such notices. Tenants should be similarly notified before utility service is interrupted, the elevator is shut down, or common areas are worked on. In general, it is a good idea to have regular communication with all tenants before and during an occupied rehab so that everyone understands what will be done, why, and how long it will take.

1 Threshold Basis Limit is the maximum specified amount, determined by TCAC on a per unit basis (221(d)(3) limits), that a project can earn tax credits if eligible costs exceed this specified amount. A "basis boost" is an increase in this maximum amount for certain items, such as incorporating energy efficiency items and renewable energy.

2 See Section 10327(c)(5)(E) of the tax credit regulations. www.treasurer.ca.gov/ctcac.

3 For more information, see www.consumerenergycenter.org.

4 For more information, see www.pge.com/003_save_energy/003b_bus/comfort_builders.shtml.

5 "Green building is just applied common sense." Alameda County Waste Management Authority, "Green Building Guidelines: Home Remodeling," (10/2001), pg. 6, *www.stopwaste.org/gbguide.html*

6 Change order work is not competitively priced because it is performed by a contractor already on the job. "Under these circumstances, it is understood that some premium (approximately 15%) is paid for work that is not competitively priced." Maxwell, Paul A., "Measurement of A/E Errors and Omissions," Albert Kahn Associates, Inc., *www.albertkahn.com/news_art_full.cfm?artid=5*

7 Notable exceptions to this rule include issues of fire and life-safety, including seismic bracing, fire escapes and fire sprinklers.

8 In this example, no work is required by Code until the owner proposes to make certain upgrades. At that time, the Building Department may require that the work, and associated building systems, be performed in accordance with the current Code.

9 The scheduling and coordination of tenants' moves between units in an occupied rehab is a common source of delay. On a typical occupied rehab, it may take two weeks or more to relocate tenants to vacate a portion of the building for the contractor to work on. In the event that a tenant contests relocation, the delay can span months.

10 In general, separation between workers and tenants is preferred in order to expedite the work and minimize the risk of conflict. Ideally, workers and tenants enter and exit the building through separate doors, and move through the building using separate corridors, stairs and elevators. Of course, for safety reasons work areas need to be secured to prevent unauthorized people, including tenants, from gaining access.

11 Care should be taken to avoid having the contractor become de facto maintenance staff during an occupied rehab. All communications between the owner and contractor should be through designated personnel, preferably the owner's project manager. In case of emergency, when the normal lines of communication between contractor and owner cannot be followed, the project manager should be notified of any communications as soon as possible.

12 Construction dust should not be assumed to "benign." In addition to lead, asbestos is frequently found on interior and exterior wall surfaces of older buildings.

13 For an excellent, easy to use resource for understanding lead safe work practices, see, "Lead Paint Safety: A Field Guide for Painting, Home Maintenance and Renovation Work," HUD, *www.hud.gov/offices/lead/training/LBPguide.pdf.* For more detailed, comprehensive, and technical information regarding lead, including HUD's requirements for ongoing Operations and Maintenance procedures, see "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing" (also known as the "HUD Guidelines"), *www.hud.gov/offices/lead/guidelines/index.cfm.*

14 For information on State certification for lead workers, see California Department of Health Services (DHS), Childhood Lead Poisoning Prevention Branch, *www.dhs.ca.gov/childlead/*

15 Fires can accidentally ignite during construction from a variety of sources, including welding, painting, soldering plumbing pipes, cutting metal, or electrical work. The best protection against fires during construction is a general contractor that demands and enforces safe means and methods of construction for all trades on a job.

DESIGN

Exterior Spaces

Introduction 35
Entries and Streetscapes 37
Courtyards 41
Playgrounds 45

Common Areas

Introduction 49
Lobbies 51
Hallways and Stairs 57
Community Rooms 61
Communal Kitchens 65
Common Restrooms 71

Service Areas

Introduction 75
Laundry Rooms 77
Household Waste Facilities 81
Janitor Closets 89

Individual Units

Introduction 91
Entrances 97
Kitchens 99
Bathrooms 103
SRO Rooms 107

Exterior Spaces

This section will address the following subjects:

A. Entries and Streetscapes

B. Courtyards

C. Playgrounds

Introduction

Exterior spaces provide places for interaction, play, group activities, etc. They can become integral parts of the building's overall design and provide a needed break from the density and severity of many urban surroundings. However, spaces on the exterior of a building, especially spaces along a public street or alley, are often subject to intense use and even abuse. When choosing exterior materials, **durability** and **ease of maintenance** should be the guiding principles.

Entries and Streetscapes

Entryways and streetscapes in urban neighborhoods are subject to a tremendous amount of use, and occasionally, abuse. Vandalism, graffiti, theft of plantings and fixtures, loitering and "camping out" in entryways are common problems that many owners of urban buildings confront on a regular basis. Although well designed affordable housing often improves the neighborhood within which it is sited,[1] affordable housing is not immune to these larger social problems. Thus, choosing façade finishes which are durable, easy to clean and economical to repair, is very important for areas along public streets. For example, maintenance staff may need the capability to wash down recessed vestibules (such as doorways) if they are used as a bathroom, bedroom or as a place to use drugs. Limiting recessed areas along the street edge, providing a secure hose bib for cleaning, and choosing easily cleanable materials can simplify maintenance and avoid the cost of repeatedly replacing finishes and hardware. In addition, windows that look out onto the public way (and in some cases, exterior security cameras) can also discourage illegal and destructive activities by providing "eyes on the street."

The entry at 555 Ellis Street in San Francisco employs durable finishes, avoids entry vestibules, and provides industrial strength door hardware.

A major challenge is how to address the need for durability and ease of maintenance while recognizing the role that streetscapes play in contributing to vital, lively, and attractive urban environments. Most people experience buildings at the street level and are most aware of buildings' entries and façades. One of the more successful strategies for combating NIMBYism (opposition to affordable housing based on the position that "It may be a good idea, but 'Not In My Back Yard!'") is to design attractive buildings that complement the design of neighboring buildings.[2] Since neighborhood perception is important, the façade should be designed so as to extend local patterns and should employ surface materials, plantings and window openings which contribute to an attractive and active street environment. The best designs allow people inside the building to feel connected to the larger neighborhood without sacrificing privacy and security.

This lobby renovation provides built-in seating and space for furniture adjacent to the main entrance to allow for viewing out onto the sidewalk and street

Materials such as stone wainscotting and ceramic tile offer attractive, tactile, and durable exterior finishes.

Key Concepts

Durability and Ease of Maintenance: Perhaps no place is the quote from property management staff, "make it bomb-proof or easily replaceable," more applicable than when selecting street-level finish materials. Designers and developers must anticipate heavy use and abuse, and choose materials accordingly.

- ☐ Ceramic tile, stone wainscoting or even split face block along the base of the street level façade can be an attractive choice that provides a tough, durable surface. However, such materials can be difficult to rid of graffiti, which can be a significant problem on the façade of a building. Some sponsors elect to use a "sacrificial" graffiti coating that comes off when cleaned, allowing the graffiti to be removed at the same time. This approach works best if maintenance is prepared to reapply the sacrificial coating after graffiti removal. Otherwise, it is a "one-shot" fix. As an alternative, painted surfaces provide for a relatively "quick and easy" repair.[3] When a building gets "tagged" with graffiti, most building managers believe the graffiti should be removed, or painted over, as soon as possible to discourage similar acts in the future.

- ☐ "Industrial" strength hardware should be used for principal entry doors (including electronic door locks/releases and power actuated doors). If hardware fails, management will be forced to decide whether to leave the entry either permanently closed or permanently open (neither being a popular option) while the hardware is repaired or replaced. The expense of repair and replacement is exacerbated by the inconvenience to tenants and compromised security.

Energy Efficiency:[4] Exterior lights should be wired to "photo-cells" that automatically turn exterior fixtures off during day-light hours.

Indoor Air Quality: Floor mats ("walk off mats"), preferably on both sides of the main entry door, reduce cleaning requirements and can minimize the incidence of "slip and fall" accidents during wet weather. Perhaps most importantly, floor mats can substantially reduce the amount of dust and other pollutants that are tracked into the building from the outside which otherwise would degrade the quality of the indoor air.

Other Design Considerations

Safety: Large expanses of windowless, blank walls at the street level can create an unsupervised environment that fosters anti-social and potentially destructive behavior. In contrast, ground floor commercial space or lobbies with windows at street level can help create a more active street front that encourages "eyes on the street" security. In addition, where ground floor residences are placed along the street, elevating them from the street level will help to provide privacy.[5]

Accessibility: In general, sponsors should not assume that they will be allowed to modify the slope of the sidewalk in order to provide required accessibility to exterior doors. Rather, measures that promote accessibility, such as ramps in lieu of steps, should be located within the footprint of the building. Work on the sidewalk typically must be limited to improving sidewalk accessibility. Existing sidewalk slopes must be measured precisely and calculated carefully in order to design an accessible entry access.[6]

Landscaping: Landscaping can provide natural shading and "soften" the edge of a building. In addition it can increase privacy by limiting the public's ability to get close to low lying windows and doors. Hardy, native plants that thrive under local climate conditions with little additional irrigation are best for "durability" and "ease of maintenance." Some sponsors have selected plants with thorns when there was a concern about the planting area being used as a place to sit, sleep, or to "stash" contraband.

Lighting: Highlighting architectural elements, such as cornice or trim details, with exterior lights can produce a dramatic and pleasing effect as well as contribute to a well-lighted and safer street at night. However, window openings to individual units should be shielded from exterior lights in order to avoid unintentionally lighting the unit interiors.

Entrances: The use of additional volumes, voids,[7] canopies, threshold detailing, paving, etc. can give prominence to the entry. Art work or unique finishes at the entry can personalize the building and give users a sense of pride.

sketch by Gonzalo Castro

The design of the Juan Pifarre Apartments avoids a blank street wall and encourages a more active pedestrian environment by bringing unit entrances down to the street level.

Dan Adams

Providing plantings along the street at Cannon Barcus Community House in San Francisco is a "soft" approach to increasing visual privacy.

1 "Why Affordable Housing Does Not Lower Property Values," Non Profit Housing Association of Northern California (NPH), www.nonprofithousing.org/actioncenter/toolbox/acceptance/affhousingpropvalues.pdf

2 "NIMBY Resources," California Department of Housing and Community Development, http://www.hcd.ca.gov/hpd/nimby.htm

3 When selecting colors for the façade, it may be useful to consider that people frequently lean against the front of buildings, with one foot braced against the building. For buildings with light colored paint at low elevations of the façade, the resulting footprints can be unsightly and present an ongoing cleaning problem for maintenance.

4 Energy efficiency on a city-wide level can be promoted by providing secure bicycle parking. This will encourage bike use by residents and visitors alike, thereby reducing urban vehicular traffic (and fossil fuel consumption) and cutting down on associated noise and air pollution.

5 However, if the units are "stepped up" from the street, it may be difficult to ensure that these units are accessible for people with mobility impairments who use wheel chairs.

6 In San Francisco work impacting the sidewalk may need several permits and approval of three different public authorities: the Department of Building Inspection ("DBI"), the Department of Public Works - Bureau of Street Use and Mapping ("DPW-BSM"), and the Mayor's Office on Disability ("MOD").

7 As mentioned above, be aware that creating "nooks and crannies" may invite loitering by people not affiliated with the building.

Courtyards

Russell Abraham

Plaza del Sol in San Francisco includes a south-facing courtyard adjacent to community spaces providing a safe place for kids to play in a dense urban setting.

Even though courtyards can be difficult to include in urban settings, a certain amount of common outdoor space is important (and often required). Design elements can encourage use of the courtyard, and by extension, provide areas for residents to interact. Since courtyards are shared spaces, provision of durable ground cover, paving material, site furnishings, and plantings should be a guiding principle.

Whether or not tenants will take advantage of a courtyard largely depends on its design. Most successful outdoor common areas are oriented to receive ample sunlight and located close to other common spaces such as laundry facilities, community dining areas, lobbies, etc. Organizing adjacent units so that they look out onto shared areas will encourage the use of courtyards as play areas because parents may feel more secure letting their younger children play in the yards if they can be easily monitored from inside the unit.

Key Concepts

Durability and Ease of Maintenance: Courtyards must be designed to withstand heavy use (as is the case with all common areas) and also continuous exposure to the elements. Therefore, all design elements (paths, furniture, plantings) should be extremely durable. In addition, exterior courtyards must be designed with an eye toward ease of maintenance. Sufficient, secure storage must be available in close proximity to the courtyard for cleaning and gardening supplies. Hose bibs should be regularly spaced to minimize the length of hose needed to water plants and clean walkways.

Energy Efficiency: Exterior lights should be wired to photocells if they are designed to remain "on" throughout the night. Alternatively, they can be controlled by a timer, or a combination of a timer and motion sensor. Regardless of the method used, it is critical that exterior lights be turned off during daylight hours.

Recycling: Trash receptacles should be provided in conjunction with adjacent recycling containers. In addition, areas with plantings need adequate storage for compost containers so that green (compost) waste is diverted from landfills.[1] Finally, a variety of extremely durable site furnishing products (such as chairs, benches and tables) made from recycled materials are now available for common, exterior areas.[2]

Located in a dense urban setting, the south-facing courtyard at Minna Russ Apartments receives ample sunlight and employs both hard and soft surfacing. Balconies and walkways look out onto the courtyard.

Other Design Considerations

Water Conservation: Exterior plants chosen for drought tolerance help to insure that the courtyard remains verdant even during periodic droughts. Properly designed and maintained irrigation systems can provide optimal levels of water for plant growth, while minimizing staff time necessary for maintaining plants.

Climate: Shading patterns and local climate information are important for determining the amount of sunlight that will enter the courtyard and the direction of prevailing breezes.[3] Roof spaces used for exterior common areas frequently need to include "wind breaks" so that prevailing winds do not render the space uncomfortable.

Safety: Exterior common areas need to restrict access by members of the public in order for them to be secure and to be used by tenants. Adequate lighting is important to insure resident safety during the evening. In addition, toxic plants should be avoided in family housing, or in any housing that includes exterior play areas.

Accessibility: Raised planters protect plants from trampling and can make gardening accessible for people with a variety of abilities. In addition, surfaces used for pathways and patios ("hardscape") must be accessible to people with disabilities. Commonly identified "architectural barriers" that impede access for people with disabilities who use wheelchairs include cross slopes that exceed 2%, soft pathway materials that cause wheels to "dig in", and surfaces that are "bumpy" that cause pain for people with back problems who use wheelchairs.

Tenant Participation: When tenants feel a sense of "ownership" over common outdoor areas it can encourage use of the spaces and discourage negligent or destructive behavior. Creating opportunities for tenant participation in community projects (such as adding tiles to benches or creating a community garden) can foster a sense of ownership among residents.

Landscape: A combination of hardscape (pavers, concrete walkways, etc.) and softscape (grass and plantings) provides visual interest and can accommodate a variety of activities. Absent a dedicated "programmatic" need, avoid large expanses of paved/hardscaped areas as these may be difficult to use and will contribute to storm water run-off. Instead, break up large areas into smaller spaces for sitting or recreation.

1 Composting yard waste may act as a catalyst to generate tenant interest in additional recycling and compost efforts.

2 A good source of information on site furnishings made from recycled materials is the Recycled Content Product Database, sponsored by the California Integrated Waste Management Board at www.ciwmb.ca.gov/rcp

3 The Pacific Energy Center offers classes and has a "tool lending library" that can be used to determine the amount of sun that a site will receive during different times of the year.
See, www.pge.com/003_save_energy/003c_edu_train/pec/003c1_pac_energy.shtml

Playgrounds

Recycled rubber surface with a strong pattern provides a safe play surface for the kids at Minna Russ Apartments.

Many of the general issues that apply to courtyards and common outdoor areas are equally important for playgrounds. However, design and construction of playgrounds and playground equipment is an increasingly specialized field. For example, playground equipment must meet specific safety requirements. In addition, playgrounds need to be accessible to people with wide ranging abilities.

Key Concepts

Durability and Ease of Maintenance: Most modern play structures designed for common area use are quite durable. However, equipment designed for residential "back yard" use is not designed to withstand the level of use encountered in multifamily facilities.

The major maintenance concerns for play equipment are cleaning and safety. Maintenance staff needs adequate supplies to keep the play area clean, including a hose bib and possibly a floor drain. The flooring of the play surface needs to have sufficient slope to drain away water, yet be flat enough for accessibility. Finally, maintenance staff need proper tools and training to make simple adjustments and repairs to keep the play structure maintained in a safe, accessible and operational condition.

Recycling: Rubber play surfaces made from recycled tires are safe and accessible and are available in a variety of colors in either a "tile" or "pour and trowel" form.

Other Design Considerations

Toxics: Many older play structures were built using pressure treated lumber containing arsenic and other toxic materials. In general, it is a good idea to replace these older structures with modern, safe, accessible play structures.

Safety

- ☐ Posted rules and safety guidelines are recommended, and often required.
- ☐ A protective barrier, such as a fence, is very important to keep children from wandering into unsafe areas.
- ☐ Play areas need lots of clear space and are typically required to have a 6' "use zone" of unobstructed space around each play structure, and 9' between structures with a height above 30".[1]

✓ safety checklist[2]...

✓ *Make sure surfaces around playground equipment have acceptable protective surfacing.*

✓ *Check that the surfacing extends at least 6' in all directions from play equipment.*

✓ *Make sure play structures more than 30 inches high are spaced at least 9' apart.*

✓ *Check for dangerous hardware, like open "S" hooks or protruding bolt ends.*

✓ *Make sure spaces that could trap children, such as opening in guardrails or between ladder rungs, measure less than 3.5 inches or more than 9 inches.*

✓ *Check for sharp points or edges in equipment.*

✓ *Look for tripping hazards, like exposed concrete footing, tree stumps, and rocks.*

✓ *Make sure elevated surfaces, like platforms and ramps, have guardrails to prevent falls.*

✓ *Check playground regularly to see that equipment and surfacing are in good condition.*

☐ Sand boxes in an urban environment can become litter boxes or even worse, places where people might hide needles or other contraband. While sand provides an important tactile experience for infants and toddlers, it must be kept clean. Finally, sand does not typically provide an accessible path of travel because it is too soft to traverse in a regular wheelchair.

Accessibility

☐ An accessible path of travel should be provided to all play areas and within each play area. Flat surfaces should have no more than 2% slope.

☐ At least 50% of the "play stations" should be accessible to people with mobility impairments who use wheelchairs.[3]

☐ "Wood chips" or "tan bark" has often been used in the "use zone" around play equipment. However, these materials frequently present accessibility problems for people with mobility impairments who use wheelchairs. Rubber play surfaces provide safety in "use zones," without the accessibility problems created by wood chips or bark.[4]

General Design Issues

☐ Play areas that appeal to children of differing ages and abilities encourage interaction and allow families to play together. However, infants and toddlers typically need a separate, secure area so that they are not inadvertently injured by older children.

☐ Location, orientation and color of play equipment can be very important. For example, dark or reflective equipment (such as a slide) placed in direct sunlight can get very hot. However, as with all outdoor spaces, locating play areas so that they receive adequate sunlight (especially in a climate such as San Francisco's) will encourage their use.

☐ Provide a water source (drinking fountain) to help keep children adequately hydrated while playing.

1 Source: Handbook for Public Playground Safety by the US Consumer Product Safety Commission, Pub. No. 325. http://www.cpsc.gov/cpscpub/pubs/325.pdf.

2 Ibid.

3 When designing accessible play areas, it is important to provide accessibility for children and for parents with disabilities in order to provide a safe, enjoyable experience for all users.

4 For accessibility guidelines for play areas, see: www.access-board.gov/play/finalrule.htm

Common Areas

This section will address the following subjects:

A. Lobbies

B. Hallways and Stairs (Circulation)

C. Community Rooms

D. Communal Kitchens

E. Common Restrooms

Introduction

Common areas (sometimes referred to as "public areas") include both areas of utility (such as restrooms and hallways) and spaces for social interaction (such as lobbies and community rooms). Common areas are typically places of heavy traffic and use requiring materials that are especially durable and easy to maintain. Consulting with property management personnel and maintenance staff during the design phase will help to ensure the choice of appropriate building materials. Ideally, even the more utilitarian spaces such as hallways or stairs can be designed in such a way that casual social interactions can occur and are even encouraged. For example, paths of circulation that are integrated with or adjacent to common areas, and which incorporate natural light, views, and provide sitting areas (including space for people with mobility impairments who use wheel chairs) can become prime locations for casual interaction among neighboring residents.

Lobbies

Lobbies serve a variety of important functions in multifamily residential buildings. A lobby may act as the living room, reception area, mailroom, security desk, and even loading dock. Durability is the number one "key concept" because almost everyone passes through the lobby when they enter and leave the building. In addition, since the lobby is, among other things, the "grand entry and living room" of the building, aesthetic concerns are very important. In spite of these multiple, and sometimes conflicting uses, lobbies should be inviting, accessible and safe for visitors and residents alike.

Mark Citret

Ample glazing and a clear line of site to the front door ensures that reception staff at this transitional housing facility for women can control access to the building.

Key Concepts

Durability and Ease of Maintenance: In light of the anticipated heavy use of the lobby, property management should be invited to provide input on the design. Durable, easy to maintain finishes, fixtures and furnishings will offer savings over time ("life cycle costs"). Since a lobby represents a relatively small area within the overall building, this is an area where durable materials may be specified that may be too expensive to be used throughout the entire project.

- ☐ Front door: The main entry door, including any hardware or electronic lock release, needs to extremely durable because it is used almost constantly. The consequences of having a broken or unusable entry door can be significant in terms of security, accessibility and inconvenience.

- ☐ Flooring: The incredible durability of marble or granite floors can sometimes justify the high initial cost in limited high traffic areas such as the entrance and elevator lobbies. Other preferred flooring materials include: stained concrete, terrazzo, linoleum, wood or bamboo, and tile. Though usually the first choice for initial cost considerations, carpet should be the last choice for durability in high traffic areas. In addition, carpet presents certain indoor air quality ("IAQ") concerns (see Section 3, Materials: Carpet).

- ☐ Walls: Dirt and damage to walls is inevitable in high traffic areas such as entries and lobbies. Placing "wainscoting"[1] on walls for extra protection helps to reduce future maintenance and repair costs. Wainscoting can be made from almost any durable material, including wood, tile, plastic, or stone. Tall wood baseboards, chair rails, and corner guards also help to protect walls against normal wear and tear and damage caused by furniture moving.

specification tip...

Often the first choice for initial cost considerations, carpet should be the last choice for durability in high traffic areas.

- ☐ Furniture: Lobbies use a variety of furnishings, including chairs, benches and couches. Opinions vary on the relative merits of hard vs. soft surfaces (durability vs. comfort). Regardless of the ultimate decision, furnishings need to be easily cleanable and sturdy.[2]

- ☐ Cleaning and Replacement Supplies: "Ease of maintenance" means more than simply choosing durable materials. It also means that supplies should be located nearby in order to simplify cleaning. In addition, fixtures and finishes should be easily repairable or replaceable with ready available supplies from local sources. Things that are complicated to fix, or that require special parts that are difficult to obtain, will remain broken for a longer period of time.

Indoor Air Quality ("IAQ"): IAQ starts at the front door. One of the easiest ways to minimize the amount of pollutants within a building is to limit the amount that are tracked in from outside. That means a good floor mat, or series of floor mats, at the front entry door. Recessed floor mats have the added safety advantages of reducing a potential trip hazard. However, recessed mats may need to be custom ordered, so it is a good idea to consult with property management, and to prepare for it early in the design process.

Recycling and Trash

- ☐ Recycling: Insuring that the design includes space for recycling is particularly important if there will be vending machines or if newspapers will be available in the lobby.[3]

- ☐ Rehabs & Trash Removal: If at all possible, the lobby should not be used as the route for removing trash from the building. However, on some rehabs it is difficult to avoid. In that case, the lobby floor covering should be easily cleanable and durable enough to handle the type of trash containers that will be used, sometimes on a daily basis. If the building has a trash compactor, the floor choices are limited because relatively few surfaces can handle the tremendous weight that a fully loaded dumpster concentrates on the few square inches of hard wheels.[4]

Other Design Considerations

Lobby as "Living Room": Units in affordable housing are sometimes rather small, especially in older residential hotels ("SRO's"). The Lobby can act as a grand living room for all tenants, providing a place outside of one's unit to relax, socialize, or wait for a friend. However, the demands on a lobby are tremendous. Unlike most living rooms, the lobby may be "home" to a hundred people or more who all share the same space.

- ☐ Windows: Lobbies should "connect" to the street with windows (or "storefront" glazing) that allow residents sitting in the lobby to see the street and sidewalk. Windows can improve energy efficiency by provide natural lighting ("daylighting") inside the lobby during the day.[5]

- ☐ Rehabs and existing finishes: Some old lobbies have intricate crown moldings and other beautiful trim. Sometimes the moldings and trim are intact, but have been covered by previous rehabs. Cost effective restoration of original millwork is desirable, but not always feasible particularly if the millwork is only discovered after construction has started. Exploratory demolition can uncover hidden architectural elements during pre-construction when it may be easier to include restoring the original millwork in the scope.

Reception Desk: It is important to understand the function and needs of front desk staff. The reception desk sometimes resembles a "control station" where multiple tasks are performed from a single location. Some reception desks are staffed around the clock, others may only be staffed at certain times. Some important design considerations include:

- ☐ General Design and Storage: Almost all reception desks have at least a telephone and some file cabinets. It is generally cheaper to purchase stock file cabinets than it is to custom build them. Many reception desks now have computers, printers, and security monitors. Sometimes desk staff have specialized duties, such as maintaining sign-in sheets and distributing mail, equipment (such vacuums), or laundry (particularly in older SRO's). The design should accommodate all of the known functions of the desk staff, and should provide adequate storage space for the intended uses.

- ☐ Security: The desk should be situated so that staff has a clear view of the entry door and front of the building in order to "buzz people in" through the front door and to be able to speak to people outside of the building using an intercom. If security cameras will be used,the desk will need adequate room for video monitors and possibly video recording equipment. The electronic door release (to "buzz people in"), intercom and video monitors all must be located at parts of the desk where the desk person typically works, so that it is easy to use them while keeping on eye on the front door. If multiple cameras are used, "split screen" monitors allow for simultaneous viewing of

✓ amenity checklist...

✓ *A bulletin board for community messages*

✓ *Vending Machines: Space needs to be provided in the original design to prevent vending machines from being viewed as an afterthought "plopped down" in the middle of the lobby, or interfering with the path of travel through the lobby.*

✓ *Shelves or benches to rest groceries on, particularly near the elevator.*

✓ *Drinking fountain: Consider providing two, a "high" one (for folks who have a hard time bending over) and "low" one (for people who use wheelchairs and for children).*

✓ *An accessible pay phone for persons with hearing disabilities ("TDD").*

✓ *Storage areas and bins near manager's office for reading material, communal toys, etc.*

multiple images (otherwise significant space is needed for multiple monitors). If the security system has recording capabilities, it will be necessary to provide storage space for the recording equipment. Security of desk staff themselves can also be an important consideration. Some desks are designed so that staff is on a platform slightly elevated above visitors so that it is difficult for someone to physically reach the desk staff. In addition, some security designs have even included emergency buzzers and an "escape route" for desk staff.

- ☐ Fire Life Safety: The fire alarm panel is typically located behind, or adjacent to, the reception desk. This location allows staff to monitor the panel, and the fire department to quickly find the panel when they respond to a call.

- ☐ Accessibility: The desk should be designed with adequate turnaround room and knee space so that a staff person with mobility impairments who uses a wheelchair is able to work behind the desk. In addition, the front of the desk should be accessible to visitors that use wheelchairs. The main section of the visitors' side of the countertop should be low enough for people in wheelchairs to be able to reach and transfer packages, or fill out forms.

- ☐ Connection to other areas: Sometimes the front desk is connected to the manager's office, counseling rooms or other staff areas. It is important to understand the relationship of the front desk to other areas and insure that the design provides an accessible, secure path of travel between these areas.

- ☐ Occupied Rehab: If a building is occupied during a rehab, then the demands on the front desk can increase dramatically, even as the desk itself is being relocated. Any additional burdens on the front desk should be carefully planned (such as signing in construction workers). In addition, it is important to provide for temporary relocation of critical elements (door release, intercom, phones, fire alarm panel, computer, monitors, etc.) if the existing desk needs to be temporarily relocated while a new reception desk is constructed.

Mail: Residents' mailboxes are frequently located in the lobby. This provides a secure place for mail distribution. Mailboxes that are located in full view of the reception desk tend to improve security.

- ☐ Accessibility: Mailboxes should be located within the reach range for people with mobility impairments who use wheelchairs.

- ☐ Seating: It is a good idea to provide some sort of seating near the mailboxes to facilitate the natural socialization that blossoms when residents congregate to check their mail.

- ☐ Occupied Rehab: If mailboxes must be moved during construction, it is important to coordinate with the Post Office to insure that temporary construction does not interfere with the normal delivery of the mail. (Tenants can become justifiably upset if mail is disrupted.)

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1 Wainscot is a wall covering for the lower part of an interior wall.

2 Open areas should be provided out of the path of travel and immediately adjacent to seating areas so that people with mobility impairments who use wheelchairs have a natural place to gather, relax and join conversations with others.

3 In general, anywhere a trash can is provided, equivalent space should also be provided for recycling.

4 For example, new ceramic tile installed in a lobby as part of a major rehab cracked rather quickly when fully loaded dumpsters were rolled over it a few times.

5 Windows with good NFRC ratings (see Section 3: Windows) provide excellent thermal insulation, thereby improving energy efficiency and insuring that the area next to the windows is comfortable, and therefore more likely to be used.

Hallways and Stairs

Linoleum proves a durable and easy to maintain surface in hallways and allows for lively colors and patterns. Ample glazing at the Rosa Parks Senior Center, pictured above, further enlivens the space.

Hallways, corridors and stairs are places of high traffic. Investing in high quality, durable materials, and anticipating areas of wear and damage, will save money in operating and replacement costs over the long term ("life cycle costs"). Communicating with maintenance staff early in the design phase helps to avoid common mistakes, and insure that supplies are readily available for maintaining these high traffic areas.

Hallways, corridors and stairs also play important roles in the social life of a residential building. Chance meetings and interactions between residents are likely to occur along paths of circulation. Benches or seating along or adjacent to corridors create a natural space for such casual interaction to occur, thereby helping to foster a sense of community among tenants. Ample landings and sitting areas (for resting) at stairs can be helpful, especially in facilities for seniors. Adequate light enlivens buildings and increases residents' sense of safety. In addition, natural light ("daylighting") saves energy that would otherwise be used to power light fixtures that may be left "on" 24 hours a day, seven days a week.

Key Concepts

Durability and Ease of Maintenance

- ☐ Floors: In general, hard surfaces, such as linoleum, tile, wood/bamboo, etc., are preferable to carpet in hallways because of the high traffic associated with areas of circulation. Even the most durable carpet will likely need to be replaced every 5 to 10 years[1] while a surface such as wood/bamboo, linoleum or tile can last upwards of 30 years. Longer life span means improved affordability due to lower life cycle costs.
  - o Carpet on stairs is particularly problematic because it wears out very quickly. Rubber treads offer a more durable stair covering that provides excellent slip-resistance.
  - o A carpet runner can be used over a hard surface for aesthetic and comfort purposes, while maintaining the relative ease of cleaning and maintenance associated with hard floor coverings. Carpet runners must be adequately secured in order to minimize trip hazards and to maximize accessibility for persons with mobility impairments.

- When carpet is used in corridors, hard durable surfaces should be used in particularly high traffic areas, such as in front of the elevators, stairs and trash chute.

☐ Walls can take a beating in high use areas. Large pieces of furniture and appliances are very difficult to navigate through narrow hallways and stairs. The walls typically bear the brunt of these assaults. In particular, corners can be easily damaged, and should be protected by corner guards. In addition, wainscoting or a chair rail can provide an attractive design feature as well as an extra layer of wall protection.

☐ Cleaning: An adequate number of easily accessible janitor closets facilitates cleaning and maintenance. Hard surface floor coverings typically require access to plumbing for mopping while carpeting requires regularly spaced electrical outlets for vacuuming. Preferably, janitor's closets would be located on each residential floor to help insure an attractive, well maintained building.

Energy Efficiency

☐ "Single loaded corridors" (hallways with units on only one side) can provide opportunities for cross ventilation (improving IAQ) and natural daylighting (saving energy). Although single loaded corridors tend to increase the amount of space devoted to circulation (thereby driving up initial costs), they can lower life cycle costs by reducing ongoing energy costs for lighting and ventilation. Single loaded corridors that "wrap around" common outdoor space, such as courtyards, are particularly effective in encouraging a communal environment.

☐ Windows and skylights can enliven spaces and reduce reliance on electric lighting during the day. To promote energy efficiency, artificial lights can be wired to a light sensors or photocells so that the amount of artificial lighting used is limited to what is needed to compliment natural light.

Indoor Air Quality ("IAQ")

☐ Hard surfaced floors promote good indoor air quality ("IAQ") because they don't harbor dust and allergens the way carpeting does.

☐ New carpeting may also degrade IAQ if it "off gasses" volatile organic chemicals ("VOC"). Sponsors concerned about IAQ should consider low or no-VOC, carpet and adhesives (See Section 3, Materials: Carpets).

Recycling and Trash:

- ☐ Corridors often include small trash rooms as a convenience so that tenants don't have to carry their recycling and trash all the way to the basement. The corridor adjacent to a trash room needs durable floor surfaces to handle the inevitable spills.

Other Design Considerations

Accessibility

- ☐ Durable, visually contrasting stripes at the top and bottom tread of each run of stairs improves accessibility for many people with vision impairments (and is required by Code).

- ☐ Consider how people with mobility impairments who use wheelchairs will exit the building in case of an emergency when the elevator is inoperable.

- ☐ If fire sprinkler risers or standpipes are located in a stairwell, they should not encroach upon the required clearance space for the stairs and landings. In addition, it may be necessary to install bars around any hose bibs so that a blind person using a cane can sense the overhanging obstructions. Communication with the fire department can help ensure that emergency access to hose bibs is not impeded by the location of the bars.

- ☐ Fire alarm strobes are discouraged in fire exit stairs because flashing strobes can be disorienting and pose significant problems for people with certain disabilities, including epilepsy.

Amenities

- ☐ Benches or other places to rest along hallways help create areas for casual interaction as well as assist residents who need somewhere to place groceries or other items. Any seating in common areas should include an immediately adjacent space that can accommodate a wheelchair.

- ☐ Security systems that include coverage for hallways and stairs need to be carefully located to provide the best coverage. Door alarms are available in a range of options, from inexpensive, battery operated models that only sound locally when a door is opened, to more expensive, hard wired alarms, that notify staff at the security desk or manager's office and identify which door has been opened.

installation tip...

Some owners elect to use multiple colors of carpeting in hallways. The border of the carpet contrasts with the center of the carpet. While carpet is generally not recommended for hallways, if you do specify carpet, consider using multiple colors where the edge contrasts with the center. This can allow for replacement of the higher traffic center while leaving the border intact.

Safety: Long hallways may feel unsafe to tenants. "Blind" corners, niches and hiding places along circulation paths can present both real and perceived safety concerns.

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1 One multifamily residential building had some corridor carpeting irreparably stained during tenant move-in, leading the sponsor to replace the corridor carpeting prior to the grand opening. A hard, cleanable floor covering would have saved the owner the considerable expense and trouble of replacing carpeting that was virtually brand new.

Community Rooms

John Martin

This community room at 555 Ellis Street is located adjacent to a courtyard and play area, increasing its potential for use and access to light and air.

Community rooms can be an important resource for resident meetings and organized activities.[1] Community rooms need to be used regularly in order to justify their cost and space. The most successful community rooms are central to the building's overall design rather than removed from residents' daily pattern of living. Connecting community rooms to other areas of high use, such as courtyards, lobbies, laundry facilities, communal kitchens, or main paths of circulation, will encourage their use, and improve their security.

Actual use of community rooms may depend on management policies. Spaces that require special permission by management will be less used than others. However, unsupervised spaces can quickly become a property management problem, and can present a real security risk to other residents in the building. Some community rooms are locked during certain hours of the day in order to balance use and maintenance/security needs. Scheduling activities after school in family buildings can increase the use of these spaces.

Key Concepts

Durability and Ease of Maintenance

- ☐ Floors: As with all high use common areas, hard, cleanable surfaces are preferred, including: wood, bamboo, cork, tile, linoleum, stained concrete, etc. In order to provide some of the benefits of carpeting (noise dampening and "sense of warmth"), consider area rugs on top of hard, cleanable floor surfaces.[2]

- ☐ Walls: Wainscoting made of wood, tile, marble, glass reinforced fiber board or other heavy duty wall covering is advisable to help protect walls against children playing, or other daily wear.

- ☐ In combination with wainscoting, or if wainscoting is economically infeasible, high baseboards, chair rails and cornerguards can help protect walls and add architectural interest. If they are painted, use semi-gloss at a minimum to insure that they are easy to clean. Even providing a painted "wainscot" below a chair rail will simplify touch up and repairs. When damage occurs, only a portion of the wall surface will need to be re-painted.

- ☐ The best community rooms receive a lot of use, and therefore benefit from a janitor's closet in close proximity in order to simplify cleaning and maintenance.

Energy Efficiency

- ☐ HVAC: Avoid falling into the trap of sizing "too big" of an HVAC system, "just in case." An oversized system will cost more to purchase and to operate, and will prematurely wear out due to constant "cycling" (starting and stopping). Size your system to be effective most of the time, rather than sizing it for the "worst case scenario."

- ☐ Lighting: Occupancy sensors should be used to turn off lights in unoccupied rooms. In addition, energy efficient lighting, such as fluorescents, should be provided to suit the various functions of the room: bright for meetings and for cleaning, and more subdued for daily use. Finally, dimmers which alter light intensity in response to available daylight ("daylighting") can be used with some fluorescent lights.

Indoor Air Quality ("IAQ"): Ventilation can be a challenge in a community room because the occupancy load can fluctuate dramatically, being rather high at times. Even rooms with operable windows typically need to provide mechanical ventilation.

Other Design Considerations

Safety: Connecting community rooms to other areas of high use will improve security by encouraging lots of "eyes and ears" to be nearby to pay attention to what is going on in the room.

Accessibility: Partition doors are sometimes used to divide a larger community room into two or more smaller rooms for small group meetings. However, partition doors can present accessibility problems if they require more than 5 lbs of force, or tight pinching, grasping or twisting to operate. In addition, they typically do not provide adequate privacy for full confidentiality.

Rehabs: Sometimes the only place for a community room in a rehab is in a rather isolated part of the building, such as the basement. In those cases, it may be a good idea to consider installing a security camera in the room to improve security.

Noise

- ☐ Acoustic insulation is important if the room is adjacent to living units.

- ☐ Carpet (although not very durable) is considered better at dampening noise

than hard cleanable surfaces. It is prone to staining, however, and frequent cleaning and/or replacement should be included in the maintenance budget if it is used.

General Design Issues:

- ☐ Adequate storage is typically needed for supplies, such as folding chairs and tables.
- ☐ Locating mail boxes in an area with visual access to the community room allows tenants an excuse to "check out the action" in the room before deciding if they want to join whoever might be using it.
- ☐ An accessible restroom adjacent to the community room is very desirable, but it can present security/maintenance/property management challenges, particularly if it is rather isolated from other common areas.

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1 A common play or recreation area is important for family projects, and group activity facilities are important for seniors.

2 When using an area rug, make sure it does not create a trip hazard, nor present a barrier for someone using a wheelchair.

Communal Kitchens

John Sutton

The community kitchen at the Swiss American Hotel employs durable ceramic tile counter tops and backsplash.

Communal (or "community") kitchens provide a common space for residents to prepare meals and socialize. These spaces can be an important (albeit expensive) amenity, particularly in older residential hotels with small units that lack private kitchens. Including an eating area as part of the design will help to create a kitchen that is a center of activity and circulation. Most successful communal kitchens have been designed to be extremely durable, easy to maintain, with good ventilation and ample lighting.

Actual use of communal kitchens varies widely depending on resident population and property management practices (particularly cleaning and maintenance). Poorly designed or poorly managed communal kitchens can become unpleasant, unsanitary, unsafe, and therefore under-utilized.

Successful communal kitchens benefit from vigilant maintenance and regular cleaning. Therefore sponsors should consult with property management staff (and residents if possible) throughout the design of a communal kitchen. Even the best-designed communal kitchen will become an eyesore, or worse, without adequate resources devoted to the maintenance and cleaning of the space.

In rehab projects, it is often difficult to find a suitable location for a communal kitchen. One popular option, particularly in older residential hotels, is to locate the communal kitchen in the basement, an often underutilized area. Designing a basement communal kitchen requires commitment on the part of the owner and project team to overcome likely challenges including: fire safety and egress, lack of natural lighting and ventilation, security, and maximizing accessibility for people with mobility impairments.

× commonly reported problems...

- × *Cockroaches and mice*
- × *Odors*
- × *Countertops with burns, holes, delamination of plastic laminate, and scratches*
- × *Cabinets provided but not used by tenants because their possessions disappear*
- × *Inadequate cleaning and maintenance*
- × *Inadequate lighting*
- × *Grease stains on walls and counters near the stove*
- × *No place to set hot pans*
- × *Inaccessible controls, lack of turn around space, high thresholds between the kitchen and adjoining hall*
- × *Disappearing appliance parts*
- × *Hoods provided at stoves, but not used by tenants.*

Key Concepts

Durability and Ease of Maintenance

☐ Countertops in communal kitchens encounter more use, and unfortunately sometimes more abuse, than is commonly encountered in private, residential kitchens. Scratches, burns, holes and delamination[1] are commonly reported problems. Therefore countertops need to be "bombproof" (extremely durable) or easily replaceable by in-house maintenance staff. The materials must also be easily cleanable and fire resistant.[2] Solid surfaced materials are preferred for easier cleaning. Integral "backsplashes" eliminate an unsightly seam and provide a durable, waterproof surface right where it is needed. All edges, such as the interface between the wall and the counter, should be properly sealed or caulked to prevent water intrusion, and to eliminate a path for insects and vermin.

- o Stainless steel countertops, such as those used in commercial kitchens, are an excellent choice because they are very durable, fire resistant and easy to maintain. Unfortunately stainless steel requires a very high initial investment. In addition, manufacturers sometimes recommend specialized cleaning agents to maintain the appearance. Finally, if it is ever damaged (such as due to impact, or by vandalism), the cost to repair can be prohibitive.

- o Other solid surfaces, including natural stone (such as granite) or synthetic materials such as cultured stone, aggregate stone (Silestone), solid surface (Corian), or even concrete, can perform very well in community kitchens, though some are susceptible to burn marks when hot pans are placed on them.

- o Ceramic tile countertops can also be durable, but the grout between tiles tends to collect grime and dirt. In addition, larger tiles are susceptible to cracking and breaking due to impact. Particle board or plywood should not be used as the substrate directly under a tile countertop due to problems associated with swelling and delamination caused by water absorption. Rather, a mortar bed or products such as "Durarock", "Wonderboard" (glass fiber reinforced cementitious board) or equivalent, should be specified over a plywood base for improved durability and lower life cycle costs.

- o Another viable countertop option includes wood butcher block, which makes an excellent cutting surface, and can be strikingly attractive. In fact, it is possible to mix different counter top materials to match the use in the particular area of the community kitchen.

- Plastic laminate, such as Formica, can be problematic in high use community kitchens because it is susceptible to burn marks, and it can delaminate if water is allowed to "stand" near a seam. However, due to it's low initial cost, and relatively low cost to replace, plastic laminate can be considered by owners who are prepared to regularly inspect the surface and make repairs as necessary. Providing a fire-resistant pad near the stove can reduce burn damage due to hot pots and utensils.

At this community kitchen, gyp board was placed beneath the granite counter top resulting in considerable moisture damage. Proper detailing and material selection is essential in wet areas.

- ☐ Walls in communal kitchens need to be durable, easily cleanable, moisture resistant, and in some locations, fire resistant.[3] As with other common areas, wainscoting and chair rails can be used to improve durability. The common complaint of grease stains on walls can be addressed by providing durable, cleanable wall surfaces, and an ongoing program of regular cleaning. Painted surfaces in communal kitchens should be coated with a glossy paint to make cleaning easier.

- ☐ Floors in communal kitchens must stand up to heavy use, spills and moisture (humidity from cooking and water from cleaning).[4] Therefore only the most durable, water resistant, cleanable floor coverings should be considered, including: linoleum, tile, stained concrete, epoxy flooring (such as "dexotex"), or high quality sheet vinyl with integral color (rather than cheaper vinyl that simply has a color or pattern only on the surface that quickly wears off). Vinyl composition tiles ("VCT") are not typically recommended for communal kitchens because the tiles result in a floor surface with a lot of seams that can provide an avenue for water to penetrate down to the subfloor and cause delamination of the VCT from the subfloor. A floor drain can simplify maintenance and clean up.

- ☐ Cabinets in communal kitchens need to be the most durable available, even more durable than those used in residential units (and far more durable than those used in office areas where water is not a problem). Sponsors should consult with property management to help specify cabinets that are durable and easily repairable by in-house staff with parts that are readily available.

  - Cabinet faces or edges sometimes delaminate if they get wet from water running off the countertop, or even from high humidity if there is not adequate ventilation in the kitchen. Solid wood door and drawer panels are much less likely to delaminate than veneers.[5] Particle board substrate will degrade rapidly if it comes in contact with water, and therefore should be avoided in communal kitchens.

  - Metal cabinets can be extremely durable, though they may be rather expensive to purchase, easily dented, and can have an "institutional feel."

- ☐ Maintenance storage: Communal kitchens must have adequate storage space, preferably a janitor's closet, for maintenance and cleaning supplies.

Energy Efficiency

- ☐ "Energy Star" rated appliances, such as refrigerators and dishwashers, realize energy savings over the life of the appliances that more than pay for the marginal increased purchase cost of the appliances. Therefore they have lower "life cycle costs" that improve long term affordability and should be used whenever possible.

- ☐ Occupancy sensors should be used to insure that lights are turned off when the kitchen is vacant. In addition, fluorescent lighting (required by Code) provides high quality light in an energy efficient manner.

Indoor Air Quality ("IAQ")

- ☐ Adequate ventilation, including a ducted range hood to exhaust cooking odors, smoke, etc., is very important to protect indoor air quality.

- ☐ All seams, cracks, penetrations, and openings, including spaces between cabinets and walls, must be properly sealed and caulked in order to exclude pests (such as roaches and mice, both of which are asthma triggers) and minimize the need to use harmful chemical pesticides in the future. This requirement should be highlighted in the specifications and verified by careful inspection during construction.

Recycling: Communal kitchens need adequate space for recycling, including "green" waste such as food scrapes. As a general rule, for every square foot of space devoted to garbage, one to two square feet should be devoted to recycling.

Other Design Considerations

Safety

- ☐ Fire safety is always a very important concern. In San Francisco, only electric cooking appliances are permitted in community kitchens for fire safety reasons.[6] In addition, community kitchens must have self-closing doors to prevent the spread of fire from the communal kitchen to other areas.[7] Finally, check with local fire authorities to determine whether an Ansul-type hood and duct fire suppression system will be required (like the kind found in commercial kitchen exhaust hoods).

- ☐ The personal safety of people using the communal kitchen can be improved by locating the communal kitchen near other areas of high use to help create visual connection between the kitchen and other common areas. Alternatively, security cameras can help staff to "keep an eye" on the communal kitchen, even if it is located in a remote area of the building, such as in the basement.

Accessibility: Obviously, communal kitchens need to be accessible to people with disabilities, including people with mobility impairments who use wheelchairs. Common accessibility problems include: lack of turn around space; counters not at proper heights or lacking knee space underneath; non-compliant "reach range" for cabinets, closets, appliances, outlets and controls; steep, high thresholds between the kitchen floor and adjoining floors; and floors with a slope greater than 2%.

Rehabs: High-density existing buildings, such as residential hotels, may only have adequate space for a communal kitchen in the basement.[8] The basement location may be difficult due to issues related to accessibility (including elevator service) and fire safety (including a rated fire exit corridor).

Noise: Due to the relatively high level of noise associated with many people simultaneously cooking (and eating), acoustic insulation is recommended when communal kitchens are located adjacent to units, offices or other spaces that are used for activities that might be disrupted by such noise.

Tenant storage: Storage in a communal kitchen is a challenge because things tend to "disappear" if they are left unsecured. However, when each tenant is provided with locked storage, improperly stored food can create a real nuisance that can be difficult to remedy. One option is to organize tenants into smaller groups and assign space to each group within an energy efficient refrigerator and a ventilated cabinet/food locker space.[9] Whether communal or individual, it is typically preferable for all food storage areas to be located away from the shared cooking surface. Heat and steam from the cooktop can hasten the spoiling of food, and separating cooking and storage can facilitate the use of the space by more than one person at a time.

1 "Delamination" occurs when different layers separate from one another, such as when a plastic laminate countertop surface peels off from the substrate (typically particle board or plywood) to which it had been glued.

2 "Countertops shall be of noncombustible construction." 2001 San Francisco Building Code ("SFBC") sec. 310.2.4.3. In addition, one commonly reported problem with communal kitchens is a lack of place to set hot pans.

3 "Where a wall of combustible construction is located closer than 24" to an electric plate, a wall guard consisting of sheet metal ... or other approved materials, shall be secured to the adjacent wall directly to the rear of the electric plates ... extend[ing] a minimum of 24" above the cooking top for the full width of the appliance." SFBC sec. 310.2.4.2.

4 SFBC sec. 310.2.4.4 requires that communal kitchen floors be waterproofed.

5 A cabinet veneer is a thin layer (often wood or plastic "melamine") glued to the substrate (often plywood, MDF, or even particle board) to improve the appearance without the initial cost of solid wood.

6 SFBC sec. 310.2.4.2.

7 SFBC sec. 310.2.4.4.

8 Generally speaking, communal kitchens should have more than ten square feet of space (not including cabinets or other fixtures that are not readily removable) for every guest room served. SFBC sec. 310.2.4.1.

9 One storage cabinet with 4 square feet of storage is required for every guest room. SFBC sec. 310.2.4.3.

Common Restrooms and Bathrooms

Mark Citret

This shared restroom at the Coming Home Hospice uses durable ceramic tile as a tub surround, flooring, and wainscotting material.

Common (or "communal") restrooms[1] are typically located on the ground floor adjacent to common areas for use by staff and residents. Common bathrooms[2] are most commonly located on each residential floor in older residential hotels ("SROs") that lack private bathrooms within each unit. Common restrooms and bathrooms should be extremely durable, easily cleanable, well-lit, and fully accessible.[3]

Restrooms and bathrooms are inherently private spaces. Unfortunately, this privacy can provide an opportunity for people to engage in destructive behavior, for example, by damaging toilets. While some damage may be unavoidable, common bathrooms and adjacent areas should be designed to minimize water damage caused by overflowing plumbing fixtures.

The rehabilitation of an existing common bathroom should always be preceded by careful exploratory demolition to determine the presence and/or extent of dryrot (deterioration of wood due to water infiltration), as well as to verify assumptions regarding plumbing and electrical systems. One of the most common change orders in many rehab projects involves repair due to dryrot in bathrooms. Unexpected dryrot repair costs can be minimized by careful inspection and exploratory demolition prior to bidding the work.

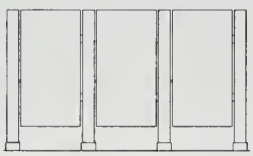
Key Concepts

Durability and Ease of Maintenance: Common bathrooms are "wet environments" that are used 24 hours a day, 7 days a week. Virtually every durability issue raised in this Handbook applies to common bathrooms. Since repairing communal bathrooms in an occupied building can be extremely difficult, only the most durable materials should be selected, and they must be installed and maintained properly.

- ☐ Flooring: Tile or epoxy (including "Dryvit") flooring performs well in communal bathrooms. Sheet vinyl is generally not recommended because it typically lacks the durability necessary to withstand heavy, constant use. "Coved" flooring[4] is excellent for preventing standing water from seeping into the wall cavity at the joint where the flooring meets the wall, although it

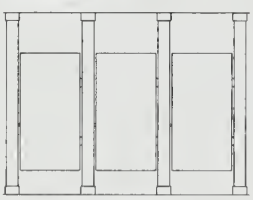
Toilet partition mounting options

CEILING-HUNG:
Easy floor access



FLOOR-ANCHORED:
Sturdier; recommended for modular use

OVERHEAD-BRACED:
More durable



FLOOR-TO-CEILING ANCHORED:
Most durable and vandal resistant

is only available in a limited number of flooring materials. Sponsors should consider water resistant flooring (including linoleum) in areas adjacent to communal bathrooms in order to minimize damage to adjacent floor coverings in the event of flooding.

- ☐ Floor drains are highly recommended to simplify maintenance, and to provide a "back-up" in case of flooding in the bathroom.[5]

- ☐ Walls: Wet areas, including areas adjacent to showers and sinks, need surface protection, such as ceramic tile or waterproof panels.[6]

- ☐ Plumbing fixtures must be durable and easily repairable. Consultation with property management staff can help to insure that lower grade "residential" fixtures are avoided.

- ☐ Wall hung sinks should be installed with brackets affixed to studs or blocking in accordance with manufacturers' specifications.[7] Support legs are often also used, however they can pose accessibility and cleaning problems. However, significant damage can be caused if a sink is "torn off the wall" by someone using it as a place to stand or sit.

- ☐ Common bathrooms need secure convenient storage for maintenance and janitorial supplies because these high use areas demand frequent cleaning.[8]

Energy Efficiency: Fluorescent lighting controlled by occupancy sensors will insure that lights are "turned off" when the room is vacant. For safety purposes, occupancy sensors must be located where they can detect the presence of someone in a stall with the door closed.

Indoor Air Quality: Adequately sized ducted exhaust fans are important for all bathrooms to exhaust excess moisture in order to control the growth of mold and mildew.[9] The use of "Energy Star" fans will insure that the fans are energy efficient and therefore economical to operate. In addition, fans can be wired to a timer so that they continue to run for a specified period of time even after the user has left the bathroom to insure that excess moisture has been exhausted.

Other Design Considerations

Lighting: One of the most common complaints about common bathrooms is that they lack adequate light. Common bathrooms typically need a mix of general (typically overhead) lighting plus task lighting at mirrors for personal grooming. Specifying energy efficient lights controlled by occupancy sensors.

Toilet Partitions: Various options are available for toilet partitions, including: coated steel, plastic laminate, phenolic and solid polymer plastic, and stainless

steel. Coated steel and plastic laminate are typically the least expensive options, but are also more susceptible to dents, paint chipping, and corrosion (in the case of coated steel), and chipping and delamination (in the case of plastic laminate). Polymer plastic options and stainless steel are more durable (and more expensive). Plastic partitions are available which have recycled content. In SROs and heavy use applications, recessed accessories are recommended as wall mounted dispensers can be kicked and destroyed. Recommended hardware includes concealed latch ADA handle either of polished stainless steel or chrome, coat hook and door bumper.

✓ accessory checklist...

✓ *Lockable towel dispensers. Single folded paper towel dispensers are recommended. Place at 40" above finished floor (max.) to meet accessibility requirements.*

✓ *Waste disposal. Wall-mounted units are preferred over free standing bins which can be unsightly and removed from the bathroom.*

✓ *Toilet paper holders. Two roll dispensers that use standard toilet tissue and include theft resistant rollers are recommended.*

✓ *Seat cover dispensers*

✓ *Soap dispensers*

✓ *Mirror and Frames. Stainless steel frame with integral shelf is recommended.*

✓ *Grab bars. Ensure adequate blocking and proper placement to meet ADA accessibility requirements.*

✓ *Tampon dispensers are frequently tampered with by people looking for money. Consider tampons sold at the front desk.*

1 Common restrooms do not include bathing facilities (shower or bathtub).

2 Common bathrooms include bathing facilities, though sometimes in older buildings the communal "shower room" may be physically separated from the common "toilet room."

3 For excellent accessibility design criteria, see the San Francisco Mayor's Office on Disabilities ("MOD") website at, www.sfgov.org/site/sfmod_index.asp. Click on the "Resources" link, to the "Quick Sheets" link, and scroll down to "Lavatories and Showers."

4 "Coved" flooring forms a curve and wraps up the wall, replacing typical base molding.

5 Some sponsors have provided a waterproof membrane under common bathroom floors when the bathroom is located over a ground floor commercial space.

6 Water resistant sheetrock (commonly referred to "greenboard") may not be used in MOH-funded projects as a substrate for tile in shower or tub surrounds because if the paper surface is exposed to water it can delaminate from the gypsum core causing the tile surface to fail. Rather, cement board (such as "Durarock" or "Wonderboard") is recommended in these applications.

7 Wall hung sinks in particular need to be regularly inspected and maintained to insure that the "caulk line" between the sink and the wall is intact.

8 Sponsors concerned with Indoor Air Quality should carefully consider the chemicals and cleaners used by maintenance and janitorial staff.

9 Operable windows can supplement, but should not be considered as a replacement for, adequately sized, ducted exhaust fans. Recirculating fans should be avoided because they provide little benefit even though they consume energy, make noise and represent another piece of equipment that needs to be purchased, maintained and eventually replaced.

Service Areas

This section will address the following subjects:

A. Laundry Rooms

B. Household Waste Facilities

C. Janitor Closets

Introduction

Service areas (also known as "utility spaces"), or areas dedicated to cleaning and maintenance, often receive scant attention during design. If service areas are not made a priority by the owner during the programmatic and design phases, then the designer may try to “squeeze them in” after all other programmatic issues have been addressed. As a result these important spaces can frequently be found tucked into left-over areas, too small to accommodate maintenance equipment and personnel, or too far from the spaces they are intended to serve.

In contrast, owners who communicate the importance of service areas early in the design process are more likely to enjoy the benefits of a properly maintained building over time. In order to insure that this input is timely and fits into the development schedule, maintenance staff should have the opportunity to review the schematic design before the project moves on to subsequent design phases. By understanding and valuing the needs of maintenance staff, developers of affordable housing can help to insure that buildings continue to work well and look great for the long term.

Laundry Rooms

Many of the design challenges for laundry rooms are similar to those for common bathrooms and community kitchens. All are shared common areas that are heavily used, are likely to experience water leaks or flooding, and must be capable of exhausting significant quantities of water vapor in order to manage interior humidity levels and thereby preserve indoor air quality.

Laundry rooms require some unique amenities, such as tables for folding laundry. In addition, they present some unique challenges, such as the need to maximize energy efficiency and accessibility with equipment that is often leased by property management staff, rather than provided as part of the construction process. Another challenge involves the need for careful coordination between the supplier of the laundry equipment and the mechanical engineer in order to insure that the dryer exhaust system (ducts, and fans if necessary) properly removes moisture from clothing being dried, without exhausting heat from the dryer prematurely.[1]

While laundry rooms are areas of utility, they can also be considered places of social interaction. Most residents will make frequent use of a laundry facility if it is provided. Residents are perhaps more likely to meet their neighbors while doing laundry than any other activity. Such social interaction can be encouraged by designing pleasant environments with adequate light and places to sit (space permitting). Also, locating laundry rooms adjacent to other communal areas or kids' play spaces will increase security and ease the burden on parents with small children. Finally, locating laundry rooms next to courtyards (or any open space) can make the space lighter and more pleasant.

design tip...

Locate laundry rooms next to courtyards (or any open space) to make the space lighter and more pleasant. If appropriate, provide spaces where kids can play while parents do laundry.

Key Concepts

Durability and Ease of Maintenance: In order to simplify maintenance, and thereby help to insure that the laundry room is kept clean and properly maintained, the design should include a janitors closet (located within, or adjacent to laundry room) a floor drain, and a utility or laundry sink.

- ☐ Floors: Ideally, flooring should be a continuous membrane with an integral cove. VCT (vinyl composition tile) is not recommended as it may not hold up over time because water tends to penetrate the seams between the individual tiles causing them to buckle and peel. Any flooring should be able to withstand bleach and soap spills. Recommended floors include:
  - ○ Colored concrete
  - ○ Epoxy flooring (such as Dex-o-tex) or concrete with epoxy resin
  - ○ Self leveling Portland cement based topping, such as Ardex
  - ○ Tile over "Wonderboard," mortar or "Hardibacker." Smaller tiles, such as 6"x6" tiles or smaller, help to prevent cracking .
- ☐ Washing Machine "Pans": Unfortunately, washing machines may occasionally overflow and flood the laundry room. A three-sided trough under each washing machine that slopes to a central laundry room floor drain can minimize water damage to the rest of the floor. In the alternative, a four-sided metal pan under each washing machine with a 1" drain that connects to the plumbing waste line can serve the same purpose.
- ☐ Counters: Counters provided for folding clothes are sometimes improperly used as benches for sitting. Therefore folding counters need to be adequately designed (including attached to blocking within the wall assembly) so that they will not be torn loose from the wall.
- ☐ Walls: Walls should be painted with semi gloss or high gloss for ease of cleaning.

Energy Efficiency

- ☐ Clothes Washers: Washing machines should be Energy Star rated models, or equivalent, to maximize energy efficiency and water conservation.[2] Since laundry equipment is often leased by property management after construction, rather than purchased and installed by the project during construction, coordinate with property management staff to insure that energy efficient laundry equipment is leased.

- ☐ Dryers: In general, gas dryers are significantly more efficient than electric dryers, and therefore promote long-term affordability.

- ☐ Lights: Lighting in laundry rooms should be highly efficient fluorescent, and should be controlled by occupancy sensors to insure that the lights are off when the room is vacant. Where possible, windows allow for natural lighting that can augment, or even replace, artificial lighting during daylight hours. When windows are provided, it is possible to incorporate daylighting strategies, such as light sensors that control the operation of the artificial lighting depending on the quantity of natural light available.

Indoor Air Quality:

- ☐ Ventilation: Washing and drying clothes can create very high humidity within the laundry room. Therefore it is important to provide adequate ventilation, preferably both mechanical (ducted fans) and natural (operable windows[3]) in order to prevent the growth of mold and mildew and to provide a pleasant environment for tenants.

- ☐ Caulk: All cracks bigger than 1/16" should be caulked to exclude pests such as mice or roaches that may be attracted to the laundry due to the presence of water.[4] All holes in walls, such as plumbing penetrations, should be covered with an escutcheon, and caulked as necessary.

Other Design Considerations

Security: Ideally, laundry rooms are located adjacent to other high use areas to integrate the laundry room into overall building activities. However, sometimes laundry rooms are located in the basement, or other relatively remote areas of the building. Security cameras can help to minimize the sense of isolation that may occur if the laundry room is located in a remote portion of the building. In addition, property management may elect to lock the laundry room during certain hours of the day, such as late at night, in order to minimize unauthorized activities, especially during times when it is difficult to monitor.

Accessibility

- ☐ Laundry Equipment (washers & dryers): A mix of top loading and front loading equipment will accommodate people with a range of differing abilities, including people with mobility impairments who use wheelchairs as well as people with back problems who have difficulty bending over. Alternatively, all front loading equipment can be used if they are stacked so that some washers and some dryers are on the top and some are on the bottom. Since the leasing of laundry equipment is frequently the responsibility of property management, project developers should consult with property management staff to insure maximum accessibility.

× commonly reported problems...

× *Laundry rooms are often squeezed into leftover space (next to the boiler room).*

× *Accessories are overlooked: folding tables, utility sinks.*

× *Machines overflow and damage flooring materials.*

× *Chemicals used in cleaning products damage finish materials.*

× *Inadequate ventilation causes excess dampness and damage to materials and an unpleasant environment for tenants.*

× *Counters provided for folding clothes are used as benches and are torn loose from the wall.*

- ☐ Folding tables: Tables used for folding laundry should similarly provide accessibility to accommodate a range of differing abilities, including people using wheelchairs as well as people with back disabilities that make bending over difficult (or impossible). Therefore sponsors should consider designs with varying folding table heights (and clear space underneath, as appropriate) to insure maximum accessibility.

- ☐ Seating: Any time seating is provided, an open space should be provided adjacent to the seating (and out of the path of circulation) that allows a person with mobility impairments who uses a wheelchair to join in the "conversation circle."

Fire/Life Safety: Building codes typically require that communal laundry rooms be separated from other areas by one-hour fire-rated walls, including one-hour fire-rated door and window assemblies. This often means that doors (including frames) must be steel, and any glass in a door may not exceed 100 square inches. In addition, windows typically cannot exceed 25% of the wall surface and must use fire-rated glass (often having visible "wires" running though the glass in a criss-cross pattern).

One-hour fire-rated doors also require a closer. If leaving the laundry room doors open is desirable (to connect to a play area, for example), magnetic hold open devices may be used that automatically release the doors in case of fire. Otherwise the doors may be improperly "propped open" and not provide the fire protection when needed.

Acoustical Design: Acoustic isolation ("sound-proofing") is desirable (and may be required by Code) for walls, floors and ceilings adjacent to residential spaces because laundry rooms tend to be noisy spaces.

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1 The coordination between mechanical engineer and laundry equipment provider is necessary when the dryer cannot be exhausted simply by running a relatively short length of duct through an adjacent exterior wall. This problem is most common in tall buildings, but can arise anytime the laundry room is situated so that the exhaust from the dryers must travel beyond the distance allowed by the dryer manufacturer (typically 10' or less). If the dryer duct length is too long, or has too many bends, the equipment will not work efficiently. If a duct run is assisted by a mechanical fan, then the fan must be properly sized to prevent the heat from being "sucked out" of the dryer prematurely.

2 At the time of the publishing of this Handbook, the "LightWash Program" provided rebates for the installation of water and energy-efficient commercial clothes washers in multifamily common area laundry facilities, including owned or leased equipment. For further information on this program see, www.lightwash.com, call 866-307-9274, or write Energy Solutions, 1738 Excelsior Ave., Oakland, CA 94602 Attn: LightWash Program.

3 The ability to provide operable windows may be limited by fire/life safety requirements.

4 Likely places that may need caulk to seal gaps include the baseboard, moldings, folding tables and cabinetry.

Household Waste Facilities

The collection and disposal of household waste[1] from multifamily affordable housing is a daunting task because the average multifamily unit disposes of almost 1,000 pounds of household waste per year.[2] In the recent past, a building's "waste management" plan may have simply provided facilities for the collection and disposal of trash. However, limited capacity of existing landfills, increasing disposal costs and significant environmental concerns led California to require that at least 50% of waste be diverted from landfills through "source reduction, recycling and composting" by 2000.[3] Having met the 50% requirement, San Francisco[4] and Alameda[5] counties established the goal of diverting at least 75% of waste from landfills by 2010. In order to meet these goals, both San Francisco and Alameda are implementing a system that allows for the separate collection of recycling (including paper, glass, metal, and plastic),[6] compost (including food scraps,[7] food soiled paper and yard clippings) and trash. multifamily affordable housing has an important role to play in these efforts, and therefore needs to provide adequate space for each of the three distinct components of household waste: recyclable materials, compostable materials and trash.[8] Finally, since waste collection rates are typically based on the amount of trash that is collected,[9] by recycling and composting as much as possible, developments will save money in operating costs through lower trash collection fees.

Service areas used for household waste within a building may include a variety of elements, including: "satellite" rooms (typically on each floor), termination rooms (typically in the basement), chutes, compactors and bins.

× commonly reported problems...

× *Doors to trash chutes are too small; garbage spills over the sides damaging walls and floors.*

× *Trash chute doors are too hard to open*

× *People set down their garbage to open the door to the trash room, soiling the carpet outside the trash room.*

× *Trash room is too far from tenants and there is a trail of stains leading to it.*

× *The trash room is hard to clean and smells.*

× *Trash chutes get plugged at any bend in the chute and become unusable.*

× *Recycling needs are not given enough space.*

☐ *Satellite waste rooms* are used by tenants to dispose of their household waste. Often these rooms include a door that opens to a chute, though sometimes there is only a can or bin that maintenance staff periodically empties.

- These rooms should include adequate space for compost[10] and recycling[11] bins.
- Commonly reported problems are that a "trail of stains" leads to the satellite waste room and that it is located too far away from tenants. By centrally locating satellite rooms, and by providing hard, cleanable floor surfaces in the corridors, this common problem can be minimized.
- As described in more detail below, these rooms must be extremely durable, easy to clean, and accessible to persons with mobility impairments. In addition, the design should provide for energy efficient lighting, adequate ventilation, fire protection (because fires commonly start in trash), and soundproofing.

☐ *Waste termination rooms* are typically located in the basement. Household waste collected from satellite rooms is stored here until hauled out to the collection point (typically the curb).

- The room must be adequately sized to handle the estimated quantity of household waste that the building will generate between collection cycles.[12] For example, if the building will have waste collected on a daily basis, the room can be significantly smaller than if collection will only occur on a weekly basis.
- In addition to the requirements noted for satellite rooms, the termination room should be located as close to the collection point as possible, preferably on a straight line and on the same level, to eliminate the need to haul waste up to the street, or to have to negotiate turns while maneuvering heavy carts. Of course, the path of travel from the termination room to the curbside collection point must be adequately sized to accommodate the bins that will be used.

☐ Chutes

- Chutes are preferred for convenience and pest control. Currently, chutes in multifamily affordable housing in San Francisco are only used for trash because chutes that allow for the segregation of the different components of household waste are quite expensive.
- Finding a place for a chute in an existing building can be extremely difficult. Sometimes chutes have been located off fire escapes, thereby offering open ventilation (though noise generated by falling trash can disturb tenants and neighbors).

- As with satellite rooms, sound insulation is recommended for chutes to minimize disturbance and complaints.
- The door to a chute should be as large as possible, but no larger than the size of the chute itself.
- The chutes in older buildings may not comply with current standards for size or fire protection. Any work on an old non-conforming chute may trigger mandatory upgrades to bring the chute up to current standards.[13]

☐ Compactors

- Compactors can reduce the volume of trash to be picked up by the collection agency and may therefore reduce operating expenses as well as reduce the amount of space that needs to be devoted to trash storage in the termination room.
- The route from the compactor to street must be as straight, wide and level as possible because bins containing dense, compacted trash may be too heavy to maneuver on slopes or around tight corners

☐ Bins

- Satellite waste rooms and waste termination rooms need separate bins to segregate recyclables, compostables and trash.
- Bins should have lids to minimize problems with odors, pests, and wind dispersing the contents. Fortunately the bins currently provided by most waste collection agencies now have lids.

Key Concepts

Durability and Ease of Maintenance

☐ Flooring

- All flooring within and adjacent to waste rooms, including the path of exit used to move bins from waste rooms, needs to be extremely durable.
- For service areas such as satellite rooms and termination rooms, flooring can be highly functional, such as concrete or an industrial-grade epoxy surface.
- Any common areas that may be used for the path of exit for household waste, including the hallway side of the door to the satellite rooms, should have a hard, durable floor surface, such as real linoleum.

- The path of exit for compacted waste must be able to withstand the tremendous forces that are generated when the weight of extremely heavy bins is concentrated onto a relatively small area by the wheels of the bins. Ceramic tile, typically considered a very durable surface, has failed under these conditions. Therefore, whenever possible, bins containing compacted material should not traverse finished floors in common areas. Rather, a direct route to the curbside pick-up location should be provided through service areas with highly functional flooring, such as concrete or industrial-grade epoxy.

☐ Walls & Doors: Protective coverings, especially sheet metal, provide a highly durable surface within satellite and termination rooms. They also are easily cleanable and fire resistant while providing excellent "vector control" (keeping roaches, mice, etc. out). The entire path of travel that will be used to move bins, especially corners and narrow doorways, should be designed to withstand "bumping" of bins into walls and doors.

☐ Satellite and Termination Rooms

- A commonly reported problem is that these rooms are hard to clean and that they smell. In order to make clean-up easier, these rooms should have a hose bib (preferably including hot water) and a floor drain. Recessed hose bibs are less likely to be inadvertently damaged or to be tampered with.

- A janitor's closet should be adjacent to each waste room, so that appropriate cleaning supplies are readily available.

- Chutes: Ideally chutes should be straight because they tend to get plugged at any bend, thereby rendering them unusable.

Energy Efficiency

☐ Lighting: Lighting in satellite and termination rooms should be fluorescent connected to a motion detector so that the light comes on when the room is entered and turns itself off after the person has left the room.

Indoor Air Quality

☐ Pest Control

- All cracks or openings in satellite rooms, termination rooms and chutes must be sealed and/or caulked to exclude pests such as roaches or mice. This also improves fire safety and reduces any unpleasant odors that may otherwise emanate from these facilities.

- Sheet metal covering of walls and ceilings will similarly help to exclude rodents that might otherwise gnaw through other types of materials.

- Property management should include waste rooms in any routine pest control program.

☐ Ventilation: Adequate ventilation is very important for satellite and termination rooms.

Other Design Considerations

Accessibility

☐ Chutes: One of the most commonly reported accessibility deficiencies involves chute doors that are hard to operate for people with low hand strength. Since chute doors are "fire rated assemblies," it may not be possible to alter or modify them in the field to provide greater accessibility. Unfortunately, chute doors are often designed with "T" handles that require tight pinching, twisting or grasping. In addition, they sometimes require significant force to open. One solution is to use power operated chute doors, though this can be rather expensive.[14] In the alternative, many sponsors provide assistance with disposal of household waste as a reasonable accommodation for tenants with disabilities who are unable to use the chute.

☐ Satellite Waste Rooms: If tenants need to enter the room to dispose of their household waste, then typical accessibility requirements apply, including the need for adequate clear space for a person with mobility impairments using a wheelchair to turnaround within the room.

Fire/Life Safety: A fire-rated door with a closer is typically required between any chute or room used for the storage of waste (including satellite and termination rooms) and the adjacent hallway.

Acoustic Insulation: Minimally, two layers of gyp board with insulation should surround the chute and/or satellite waste rooms. The best solution is to provide a sound cavity (an air space between layers of finish materials).

General Design Issues: A cleanable shelf or bench adjacent to the door to the satellite waste room allows tenants can set their household waste down while opening the door without soiling the floor.

1 "Household waste" includes recyclable materials (paper, plastic, metal, and glass), compostable materials (also referred to as "organic" or "greenwaste," including food scraps, food soiled paper and yard clippings), and trash.

2 The statewide disposal rate for multifamily household waste is 0.46 tons/unit/year. "Residential Disposal Rates," 1999 Statewide Waste Characterization Study, California Integrated Waste Management Board (hereinafter "CIWMB"), www.ciwmb.ca.gov/wastechar/ResDisp.htm.

3 California Public Resources Code sec. 41780 (a) (2) states that all cities or counties "shall divert 50 percent of all solid waste on and after January 1, 2000, through source reduction, recycling, and composting activities."

4 In 2002, the San Francisco Board of Supervisors adopted an interim goal of 75% waste diversion by 2010, with a long-term goal of zero waste. "Under the Waste Disposal Agreement for San Francisco's waste at the Altamont landfill, approximately 7 million tons of capacity remained as of January 1, 2001, which is less than 10 years capacity at 2000 disposal levels, and a new landfill contract could significantly increase San Francisco disposal costs". See, Resolution #679-02.

5 In 1990 Alameda County voters passed "Measure D" that established 75% and higher goals for reduced landfilling. See, "Alameda County Source Reduction and Recycling Plan, Vision 2010: 75% and Beyond" (2003) www.stopwaste.org/rplan.html (hereinafter, "Vision 2010").

6 Approximately 45% of the household waste disposed of in San Francisco is recyclable (paper, plastic, metal, and glass). See, "Profile for San Francisco County", CIWMB, www.ciwmb.ca.gov/Profiles/County/CoProfile1.asp .

7 "Food waste is the single largest category of landfilled waste..." Vision 2010, pg. 49. In fact, food waste alone accounted for almost 21% of the landfilled waste generated by multifamily housing in Alameda County in 2000. Vision 2010, Appendix B, Table ES.7, pg. 103. Similarly, food waste comprises 20% of the waste disposed of by San Francisco households, by far the single largest specific material type. www.ciwmb.ca.gov/Profiles/County/CoProfile1.asp .

8 For additional information about recycling in San Francisco, see the SF Environment website at, www.sfgov.org/sfenvironment/aboutus/recycling/fantastic3.htm . For further information about recycling in Alameda County, see www.stopwaste.org.

9 "Collection rates are set to encourage recycling. The monthly collection charge is based on the black (garbage) cart. The blue [recycling] and green [compost] carts are picked up at no additional charge." See, "Curbside Recycling Program Fact Sheet," Sunset Scavenger Company, www.sunsetscavenger.com/recycling_fact_sheet.htm

10 In San Francisco all compostable materials can be disposed of in a single bin. This is a very broad category that includes: meat scraps, bones, pizza delivery boxes, and waxed cardboard milk containers. www.sfgov.org/sfenvironment/aboutus/recycling/fantastic3.htm

11 In San Francisco all recyclable materials can be disposed of in a single bin. There is no longer a need to segregate paper, glass or metal. However, tenants or building managers may elect to voluntarily segregate those materials that have a redemption value. www.sfgov.org/sfenvironment/aboutus/recycling/fantastic3.htm

12 The average San Franciscan disposes of 1.9 pounds of household waste (recyclables, compostables and trash) per day. See, CIWMB, www.ciwmb.ca.gov/Profiles/County/CoProfile1.asp.

13 Since trash chutes are typically housed within a "chase," it can be very difficult to increase the diameter of the chute without building a larger chase. Therefore, anytime a rehab project is considering an upgrade to an existing chute, it is recommended that a "Pre-Application Meeting" be held with the fire department in order to determine the extent of any mandatory upgrades that may be triggered by the proposal to renovate the existing chute.

14 Power operated chute doors also introduce the potential for mechanical failure, which can render the chute totally unusable.

Janitor Closets

Janitor closets are small spaces used by janitorial staff to store cleaning supplies and equipment close to where they are typically needed. Although sometimes considered a "luxury" by designers, well-designed janitor closets make cleaning easier, and therefore cheaper. In order to minimize long term operating costs, and to help insure that buildings maintain their "sheen" long after their Grand Openings, sponsors should stress the importance of janitor closets. The best way to properly design and locate janitor closets is to discuss cleaning requirements with maintenance staff early in the design phase.

Key Concepts

Durability and Ease of Maintenance: Janitor closets tend to get "banged up" by carts, mop buckets and vacuum cleaners being moved in and out, so durable finishes are a must. Another important consideration is the location and number of janitor closets.

- ☐ Where possible, there should be one janitor closet on each floor, located near areas requiring the greatest amount of housekeeping such as kitchens, common restrooms, lobbies, laundries, or trash chute openings.
- ☐ It is a good idea for janitor closets to contain a sink. Floor sinks work best because they require less lifting for the janitor. Ideally, there would be both a floor and a wall hung sink to accommodate different types of tasks.
- ☐ Floor drains, located well away from the door, with positive drainage to the floor drain inlet, are highly recommended by maintenance staff.
- ☐ Janitors' closets dispersed throughout the building typically compliment, but do not replace, the need for a secure storage and work area with a desk or table for janitorial and maintenance staff elsewhere in the building.
- ☐ Flooring: Tile, epoxy (such as "dex-o-tex"), concrete, or linoleum with good slope to a floor drain is recommended. (Carpeting in janitor closets is discouraged.) In addition, it is a good idea for the flooring immediately in front of the janitors closet to also be extremely durable, and preferably water resistant.

What should the janitor closets include and accommodate?

- ✓ *proper ventilation*
- ✓ *mop/wringer*
- ✓ *paper products*
- ✓ *cleaning supplies*
- ✓ *light bulbs, electrical supplies, and flashlight*
- ✓ *safety wear (eye protection, gloves, dust masks, hardhat, rain suit, and first aid kit)*
- ✓ *waste basket and one 32 gal trash can*
- ✓ *mirror, dispensers for hand washing, towels, soap.*
- ✓ *rack for brooms, mops, vacuum*
- ✓ *shampoo & floor care machines*

☐ Walls: Fiberglass-reinforced or plastic wallcoverings work well. Any exposed wall corners that might be damaged by carts, vacuums or mops should be protected.

☐ Shelving: Particle board shelving is not recommended because it may get wet and swell. Instead, provide plywood or heavy duty (not residential grade) metal grid shelving with broom hooks. All shelving should be secured for earthquakes.

Energy Efficiency: Lighting in janitor closets should be controlled by occupancy sensors to insure that the lights are turned off when the rooms are vacant.

Indoor Air Quality: Due to the presence of cleaning chemicals and a sink, janitor closets should have mechanical ventilation. A small, ducted fan controlled by a timer may suffice. Perhaps more importantly, sponsors concerned about IAQ should carefully evaluate the cleaning chemicals used by janitorial staff.[1] Otherwise a building designed and constructed to protect indoor air quality can be polluted with volatile organic chemicals from the supplies used to clean the building.

Other Design Considerations

Fire Safety: Janitor closets located off hallways require a rated door and door closer. A magnetic hold open device at the closet door can hold the door open when necessary but release in case of fire.

1 For information on environmentally sensitive cleaning supplies, see: General Purpose Cleaners (.pdf file) (www.greenseal.org/recommendations/CGR=GPCleaners.pdf), a Green Seal Fact Sheet.

Individual Units

This section will address the following subjects:

A. Entrances

B. Kitchens

C. Bathrooms

D. SRO Rooms

Introduction

The design of individual units has a direct impact on the quality of life of tenants and the operations of a building. It really doesn't matter whether it is a room in a residential hotel (also known as a single room occupancy hotel, or "SRO"), a multi-bedroom family apartment or a multi-level townhouse, residents are likely to spend most of their time in, and feel the strongest sense of "ownership" for their own individual units. From the standpoint of building operations, the benefits of good design decisions made for individual units are multiplied many times throughout a building. For example, hard surfaced flooring that doesn't need to be replaced at "unit turnover" saves the cost of replacing carpet every time a new tenant moves in.

What isn't so obvious is what constitutes "good design"? For example, there is a range of opinion regarding the ideal size or configuration for individual units.[1] Rather than establishing a fixed set of rules intended to define "good design," this section examines and makes recommendations with an emphasis on three important areas within units: Entrances, Kitchens, and Bathrooms. In addition, some recommendations are provided for SRO units. Following are concepts and considerations which apply to units in general.

Key Concepts

Durability and Ease of Maintenance

Multifamily rental units often require more durable finishes and fixtures than what are typically provided in detached single-family homes. Higher quality products can often pay for themselves over time by requiring less frequent repair and replacement. Similarly, family units typically encounter heavier use than senior units, and therefore require more durable finishes and fixtures.

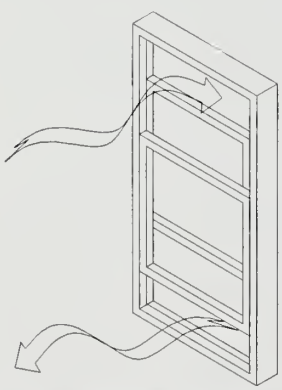
Most design decisions for units are multiplied throughout the building by the total number of units. For example, the "simple" decision of selecting the type of unit entry door hardware can become a significant issue for maintenance staff if it means fixing or repairing every entry door lock. Sponsors that manage more than one building can simplify maintenance across buildings, and thereby lower operating costs, by consistently specifying design solutions that work for them.

Energy Efficiency

- ☐ Lighting: Fluorescent fixtures are preferred because they are extremely energy efficient, provide high quality light, are cost effective, and have a proven track record. All rooms, including bedrooms, should have at least one hard wired fluorescent light.

- ☐ Windows: New windows should be dual glazed (two panes of glass), preferably with a "low-e" coating to improve thermal insulation and to exclude unwanted heat gain. Wood, vinyl, fiberglass, and thermally broken aluminum frames are the most energy efficient. Existing windows in buildings being rehabbed frequently need repairs and weatherstripping to improve energy efficiency.

- ☐ Heat: Hydronic heating[2] is preferred for energy efficiency. Electric baseboard heat should be avoided unless a life cycle cost analysis demonstrates that it is cost effective.[3]



A double hung window allows for increased air flow and ventilation. Cool air enters at lower sash and warm air escapes at upper (convection).

Indoor Air Quality

- ☐ Ventilation: One of the best ways to promote healthy indoor air quality in a moderate climate like the Bay Area is to promote natural ventilation through operable windows on opposite sides of a unit ("cross-ventilation"). However, some form of mechanical ventilation is also recommended for almost all units.

- Older buildings in the Bay Area typically had "dual hung" windows that allowed the upper sash to be lowered so that warm air at the ceiling could flow out the top of the window to the outside. Unfortunately, over the years, the upper sashes frequently have become inoperable, often from being painted shut, thereby reducing the natural ventilation in the unit below the standard for which it was designed.[4] To make matters worse, the older units frequently had an operable "transom" window above the entry door that provided a degree of cross-ventilation between the transom and the dual hung windows. For fire safety reasons, these transoms have typically been sealed shut. When the original design intent is frustrated, it is imperative that some mechanical ventilation be provided to insure that residents have adequate fresh air.

- Hard Surface Flooring: Hard surface flooring, such as linoleum, tile, wood, sheet vinyl, etc., is easily cleanable and does not harbor mold, dust, mites and other allergens the way carpeting does. Therefore, hard surface flooring is generally preferred for IAQ reasons.

- Caulking and Sealing Cracks: All cracks, particularly in the kitchen and bathroom, should be caulked or sealed to exclude pests such as mice and roaches. By excluding these pests, a common asthma trigger (mice and roach detritus) is eliminated from the unit, and the need to use toxic pesticides is greatly reduced.

- Volatile Organic Chemicals ("VOCs"): Paint, furniture, cabinets, countertop substrate, and carpeting (to name a few) can all "outgas" "VOCs" that may be harmful to residents, particularly to those with multiple chemical sensitivities.[5] One way sponsors can reduce VOCs in units is by limiting, or eliminating the use of particle board. When particle board is used, sealing all exposed particle board surfaces will drastically limit emissions.[6] Similarly, the use of low-VOC paint and materials with no added urea-formaldehyde can also significantly reduce VOC emissions within units.[7] In addition, certified low-VOC carpet is now available.[8]

specification tip...

Sealants themselves can contribute to indoor air quality problems by emitting harmful VOCs. Specify only low-VOC products safe for indoor use, such as:[11]

- *oleo resinous*
- *acrylic emulsion*
- *polysulfide*
- *polyuretuane*
- *silicone*

Other Design Considerations

- Avoid dedicating excessive space to circulation in order to minimize unit size while maximizing room size.

- Design rooms that can accommodate multiple activities. For example, a dining area which includes an accessible nook or corner table to be used as a desk for homework can be a nice amenity for a family with children.

- Where possible, provide a visual connection between the more public areas of the unit (living, kitchen, dining) to give a sense of spaciousness to an otherwise small apartment.

- ☐ Test out various furniture arrangements to ensure that the space can be easily furnished in an accessible manner and work in a variety of different ways.[9]
- ☐ Consider placing windows at 36" (min) above the finished floor. This will permit the placement of furniture (beds, tables, desks, chairs, etc.) beneath the window. However, remember that the maximum sill height allowable for egress windows is 44" above the finished floor.
- ☐ In general, provide as much accessible storage space as possible.
- ☐ Every sleeping room below the 4th story is required to have a second means of egress to a public way (the door to the bedroom being the first means of egress). This second egress or exit is most commonly a window that must have a clear opening of at least 5.7 square feet.[10]

---

1 California Housing Finance Agency ("Cal HFA") offers minimum dimension guidelines for units they fund in Attachment II to their Multifamily Program Architectural Processing Requirements available online at www.calhfa.ca.gov/multifamily/financing/app-process/arch-manual.pdf (hereinafter "Cal HFA Development Standards.") However there has been considerable debate whether it is better social policy to build fewer, larger units, or more, smaller units.

2 Hydronic heating uses a central boiler, or individual boilers within each unit, to heat water that is distributed through pipes to radiators to provide heat. A central boiler is more energy efficient (and space efficient) than multiple, individual boilers. However, individual boilers are sometimes preferred because they allow for individual metering for space heating.

3 Due to the inherent inefficiencies in using electric resistance for a heat source, electric baseboard heat is only permitted under the Code (Title 24) when the designer can demonstrate that sufficient energy savings are realized by other building systems. Thus the "true" initial cost of electric baseboard heat should include the costs of other energy efficiency measures that create sufficient energy savings to allow electric baseboard heat to be used ("whole building analysis"). However, it is very difficult to exceed the Code in a cost effective manner when using electric baseboard heat using the prescriptive method. www.energy.ca.gov/title24.

4 In rehabs, all operable windows should be checked to insure that each window has at least one operable sash. Surveying and repairing existing windows can be quite time consuming and expensive, but it is very important so that the building can at least function as it was originally designed, even though it may no longer meet current codes for ventilation.

5 Many resources recommend "airing out" materials, and even buildings, prior to occupancy. However, the demand for affordable housing is so great that rarely, if ever, are units held vacant in order to allow VOCs to offgas prior to occupancy. In addition, many of the materials that may emit VOCs are often installed rather late in the construction schedule, including caulking, painting and carpeting. Therefore, the better solution is to limit the use of materials that offgas VOCs, thereby allowing residents to move quickly into completed affordable, healthy units.

6 HUD Rehab Guide, Vol. 6, "Kitchens and Bathrooms", pg. 28.
www.huduser.org/publications/destech/rehabgds.html

7 The use of low VOC finishes, such as interior paint and carpet, is something that should be coordinated with maintenance staff in order to insure that once the building is occupied, low VOC finishes will continue to be used. In fact, the maintenance staff itself can receive the greatest benefit from using low VOC finishes because maintenance workers are frequently exposed to off-gasing of materials when painting and installing carpet in occupied buildings.

8 The Carpet and Rug Institute has established a voluntary "Green Label" program that uses an independent laboratory to certify that certain carpet products (carpet, pad and adhesives) are low-VOC emitting.
www.carpet-rug.com/drill_down_2.cfm?page=8&sub=6

9 Cal HFA Development Standards provides "Minimum Dimensions/Furnishability Guide for Apartment Unit Plan Layouts," Part II, page 22 or 25. www.calhfa.ca.gov/multifamily/financing/app-process/arch-manual.pdf.

10 When a window serves as the second means of egress, the width cannot be less than 20" and the height not less than 24. Calif. Building Code section 310.4.

11 Greenspec Directory, Building Green, Inc., Siegel and Strain Architects, p.146

Entrances

This recessed entrance at Minna Park Apartments provides covered overhangs and plenty of space for personalization.

Entrances can either be exterior spaces, such as townhouse entrances, or interior spaces, such as entrances connected to an interior corridor. While exterior entrances introduce the need for weather protection, all entrances need to be inviting, well lit, secure and extremely durable. Whenever possible entrances should promote "visitability"[1] by being designed to be accessible to people with mobility impairments who use wheelchairs, regardless of whether the entire unit is considered accessible.

Key Concepts

Durability and Ease of Maintenance: Door hardware should be high quality so that it works properly over time.[2] Broken entry door hardware undermines security, inconveniences tenants and creates a significant burden for property management. In addition, the flooring just inside the entry should be a hard, durable surface, even if carpeting is used throughout much of the rest of the unit. Linoleum or sheet vinyl with integral color throughout the thickness of the material can work very well in this application.

Energy Efficiency: Units with entrances which front an outdoor area should have an exterior light on a motion sensor or photo cell to ensure energy conservation during daylight hours.

Other Design Considerations

Accessibility: Entrances should be accessible to people who use wheelchairs. Even if the entire unit is not technically "accessible," providing accessible entries will increase "visitabilty," allowing family, neighbors and friends with mobility impairments to visit more easily.

General Design Issues:

- ☐ Recessing the door from the path of circulation and providing a plant ledge, bench, or niche will provide areas for placing groceries or supplies when entering the home as well as give the resident an opportunity to personalize their entryway. However, be mindful that exterior recesses can, in some neighborhoods, become a magnet for unwanted behavior by members of the public, including using the recess as a sleeping area, or worse.

- ☐ Providing some visual connection between the unit and exterior corridor, or path, can help to increase security as well as heighten possibilities for casual encounters. For example, windows from a kitchen area to the path of circulation will encourage "eyes on the street security" as well as give neighbors the opportunity to greet each other when entering or leaving nearby apartments.[3]

---

1 HUD promotes the concept of visitability in order to offer "the opportunity for a disabled person to visit the home of a friend without having to be lifted up the stairs, to enjoy a meal and be able to use the first floor bathroom ..." See, "Suggestions for Providing Accessibility & Visitability for Hope VI and Mixed Finance Homeownership," 1/2000, available online at www.huduser.org/Publications/pdf/strategies.pdf

2 Cal HFA Development Standards require that "Locksets shall be primarily of steel construction with a five pin tumbler lock, and a one-sided, keyed, dead-bolt installed above the lockset. Schalge series F or equivalent is acceptable." Part II, page 10 of 25. www.calhfa.ca.gov/multifamily/financing/app-process/arch-manual.pdf. Some sponsors of affordable housing recommend using durable, commercial grade door hardware.

3 However, per California Building Code Section 2406.4, glazing within 24" of either side of a door jamb (lock side or strike side) and whose bottom exposed edge is within 60" of the walking surface, must be tempered safety glazing.

Kitchens

Sheet flooring such as natural linoleum used at the Oak Park Apartments in Oakland provides an attractive and water resistant flooring appropriate for kitchen applications.

Kitchens present significant design challenges because of high levels of use coupled with the presence of food (including trash, recycling and compostable scraps) and water (including steam from cooking). Kitchens also present tremendous opportunities for energy efficient lighting and appliances (particularly refrigerators). The presence of food and water make kitchens a likely target for roaches, mice and other pests whose detritus can be an asthma trigger for a significant percentage of the population. In addition, the steam and odors from cooking can degrade indoor air quality and promote the growth of mold and other allergens if they are not properly exhausted to the exterior.

Key Concepts

Durability and Ease of Maintenance

- Cabinets: A common design mistake is to select cabinets that look attractive but are not designed to withstand the real world demands of multifamily affordable housing.[1] Sponsors should consult with their maintenance department to understand which types of cabinets are working well, and which are not, at other buildings. In general, cabinets with plywood boxes, solid wood doors and solid back panels are preferred.[2] Particle board is discouraged because it may deteriorate rapidly when it gets wet. In addition, cabinet hardware should be carefully selected for durability and ease of maintenance. Some sponsors prefer simple, exposed "barrel" hinges that can be easily replaced by maintenance staff without special tools or skills. (See Section 3, Materials: Cabinets).

- Floors: Water-resistant flooring is required. "Sheet goods" (resilient flooring that comes in wide rolls) are typically more durable than similar material in tiles because sheet goods minimize seams. Flooring tends to "peel up" at seams because seams trap dirt and water.[3] Linoleum, vinyl flooring with color/pattern extending through the full thickness of the material, laminates,[4] tile, and even wood can all be extremely durable floor coverings in individual unit kitchens.

- Countertops: The range of materials for countertops is increasing rapidly. By far the most common type of countertop material used in multifamily affordable housing is laminates (such as Wilson Art, Formica, etc.). These surfaces have low initial cost and are easy to clean. An important advantage is that they can be shaped to include an "integral backsplash" to

✕ commonly reported problems...

✕ *Stoves set against the wall with no hood can cause paint to peel from the adjacent wall and dirt to build up between the stove and the wall.*

✕ *Grease can build-up at walls and especially at the old vent pipe. Sheet metal or ceramic tiles at the wall approx 18" above the stove surface will help to protect the wall but can be subject to similar grease build up.*

✕ *Cabinets above the stove also become areas for grease build up. Varnished cabinets create a fire hazard.*

✕ *Grease can build up at exposed pipes in the kitchen. It is recommended that all pipes in kitchens be concealed.*

eliminate a seam where the counter meets the wall, as well as a drip edge, to minimize water from dripping onto the lower cabinets. Unfortunately, laminate counters are relatively easily burned, and typically are not as durable as other counter top material choices, such as cultured stone, aggregate stone (Silestone), solid surface (Surell, Corian, etc.), ceramic tile, stone, butcher block, stainless steel, or even concrete.[5] However, some maintenance departments have staff experienced in replacing laminate countertops, thereby minimizing the burden on operating costs by performing the work in-house.

Energy Efficiency

☐ Refrigerators (and dishwashers if they are provided) should be EnergyStar rated.[6] In addition, refrigerators should be auto-defrost whenever possible.

☐ The Code requires that the most accessible light switch in a kitchen be wired to a fluorescent lamp.[7] If more than one light fixture is provided in a kitchen, all should be fluorescent to maximize energy efficiency.

Indoor Air Quality

☐ Ducted range hoods that exhaust to the exterior are very important for removing steam, smoke and cooking odors from indoor air. Recirculating range hoods are strongly discouraged because they do very little to improve IAQ even though they can be noisy, use energy and represent another piece of equipment that needs to be maintained, repaired and ultimately replaced by maintenance staff.

☐ All holes or cracks bigger than 1/16" should be caulked or filled in order to exclude pests such as roaches and mice, particularly around plumbing and electrical penetrations, cabinets,[8] countertops and baseboards. The presence of such pests can trigger asthma problems in many individuals.

Recycling: The kitchen should be designed with space for at least two receptacles (recycling and trash), and preferably three (recycling, compost and trash).

Other Design Considerations

Accessibility: Countertops in accessible units need to be repositionable (raised or lowered) without the use of specialized tools or knowledge.[9] In addition, controls, such as for range hoods, need to be within specified reach ranges to be usable for people with mobility impairments who use wheelchairs.

Fire/Life Safety: Cabinets above the stove provide an area for grease to build up and create a fire hazard. A ducted range hood above the stove is preferred to reduce this fire hazard.

General Design Issues

- ☐ All counter top outlets (plugs) must include a Ground Fault Circuit Interrupter (GFCI).[10]
- ☐ Grease builds up at exposed pipes in the kitchen, therefore all pipes in kitchens should be concealed.
- ☐ A visual connection to other spaces within the unit can make a small kitchen feel more spacious. A dropped soffit between the kitchen and living areas may serve to delineate each area and to contain grease vapors within the kitchen.

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1 Cal HFA's Development Standards, Attachment 1, establishes minimum specifications for cabinets in Cal HFA funded projects. www.calhfa.ca.gov/multifamily/financing/app-process/arch-manual.pdf

2 One of the contributors to the original Materials Handbook, George Drake had very specific recommendations for cabinets: a sturdy plywood box with panel doors and solid wood rails and stiles. The solid wood rails and stiles were critical because hinge screws hold best in solid wood, and the solid wood held up best when water dripped on it. George also was fond of pointing out that these types of cabinets are readily available, frequently at a lower initial cost than those specified in many projects.

3 However, vinyl composition tiles ("VCT") are preferred by some sponsors because individual tiles can be replaced as necessary, rather than triggering the replacement of the entire floor covering when a limited area is damaged.

4 Laminate floor coverings, such as "Pergo" can be extremely durable. However, laminate floor coverings are made of layers, and therefore they do not have an integral color/pattern extending through the full thickness of the material. Instead the top layer (wear layer) is bonded to a central core (typically high density fiberboard). The performance of the product is dependent upon the durability of the top "wear layer." Therefore, not all laminate floor coverings "are created equal."

5 For a good review of maintenance and repairs for various countertop materials, see, The HUD Rehab Guide, Vol. 6, "Kitchens and Baths," pgs. 25-27. www.huduser.org/publications/destech/rehabgds.html

6 EnergyStar rated appliances can be found at www.energystar.gov . On January 1, 2003, the Department of Energy expanded the ENERGY STAR refrigerator category to make all classifications of refrigerators and freezers eligible for ENERGY STAR qualification. The category expansion allows all refrigerators and freezers 7.75 cubic feet or greater in volume to qualify for ENERGY STAR if they are 10% more efficient than the federal standard, regardless of configuration or defrost type. All refrigerators and freezers less than 7.75 cubic feet are eligible for ENERGY STAR qualification if they are 20% more efficient than the federal standard.

7 Title 24 (2001 AB 970), Part 6: Subchapter 4, Sec. 130(b)(1) and Subchapter 7, Sec. 150(k)(1).

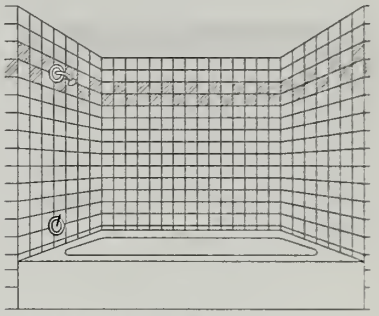
8 Cabinets should be installed with "tight backs" to exclude pests. Careful attention should be paid to cabinet installation, particularly where plumbing pipes penetrate the back of a cabinet, such as under the sink.

9 Calif. Building Code sec.1112A.

10 Rehab projects frequently are required to upgrade and add outlets in kitchens, even if no other electrical work is being performed. If possible, it is a good idea to clarify these requirements with the building department prior to submitting for a building permit in order to minimize unforeseen code interpretations, and costly change orders, during construction.

Bathrooms

Bathrooms present design challenges similar to kitchens because of the combination of high levels of use and the presence of water (including moisture vapor). Finishes need to be extremely durable, easily cleanable and able to withstand moisture. Rehab projects frequently encounter dryrot in bathroom framing due to plumbing leaks which have occurred over time, so exploratory demolition in these areas can help to minimize unforeseen conditions that might otherwise lead to costly change orders during construction.



Tile is a durable choice for tub surrounds which allows for integration of accent colors. Install over mortar bed or cementitious board (greenboard is not an acceptable substrate) and caulk where tile meets tub.

Key Concepts

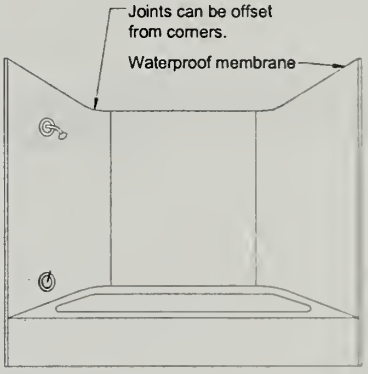
Durability and Ease of Maintenance

- ☐ Floors: Tile is a preferred flooring material in individual unit bathrooms, though the initial cost is comparatively high.[1] Sheet vinyl is an acceptable option because it is a seamless flooring, and can be "coved" to eliminate the seam at the junction between the wall and the floor. Vinyl Composition Tile ("VCT") is not recommended in bathrooms because the seams collect dirt and water, leading to deterioration over time.

- ☐ Wall hung lavatories ("lavs" or sinks) are susceptible to "sagging" or even being completely pulled off the wall because they are sometimes used as a seat or ladder. Lavs must be adequately attached to the structural framing or blocking and must be regularly inspected to insure that the caulk line between the lav and the wall is maintained.[2]

- ☐ Wall surfaces around lavs are a high moisture area and therefore a water resistant wall covering such as tile, thermoplastic or fiberglass should be provided to protect the wall from splashes and spills.

- ☐ Tub/Shower Surrounds: Tile is an excellent tub/shower surround material,[3] though solid surface surrounds (acrylic or polyester) can also work very well in individual unit bathrooms. However, only extremely durable materials should be used on the floor of roll-in showers due to the weight that is concentrated on the small surface area of the wheels. Windows within a surround (as sometimes occurs in rehabs), should have synthetic sashes or frames (such as vinyl) to better withstand exposure to moisture from both the interior and exterior.



Solid surface surrounds include plastic and fiberglass. Caulk joints carefully and clean per manufacturer's recommendations.

maintenance tip...

Regularly scheduled and periodic maintenance checks can spot leaks or other plumbing problems before they cause structural problems or damage finishes.

Energy Efficiency

- ☐ Bath exhaust fans should be EnergyStar rated to insure that they are quiet and energy efficient.
- ☐ Heat lamps are expensive, inefficient and should be avoided.[4]
- ☐ The Code requires that the most accessible light switch in a bathroom be wired to a fluorescent lamp.[5] If more than one light fixture is provided in a bathroom, all should be fluorescent to maximize energy efficiency.

Indoor Air Quality

- ☐ Adequate ventilation is essential to minimize mold and other moisture related problems. Perhaps the best way to ensure adequate bath ventilation is to install a quiet electric exhaust fan ducted to the exterior and wired to a timer on the same switch as the bathroom light. The timer allows the fan to run for a pre-set period of time after the switch is turned off. Fans on their own switch are often not used (especially noisy fans).
- ☐ An operable window in the bathroom providing natural ventilation can compliment a simple exhaust fan.[6]
- ☐ The lightwells in many older apartment buildings and residential hotels may be quite narrow and tall, and therefore may be inadequate for venting bathrooms without some mechanical fans at the roof.[7] For example, small bath exhaust fans typically do not have the capacity to "push" exhausted air up several stories to the roof level. Therefore a larger fan may be necessary at the top of the lightwell to assist in exhausting air from the bathrooms. In addition, poorly maintained lightwells can become "trash dumps" if tenants toss debris out of windows.[8] Finally, like almost any protected horizontal exterior space in the City, lightwells can become "roosting" spots for pigeons, causing the air in the lightwell to be fouled by their droppings.

Other Design Considerations

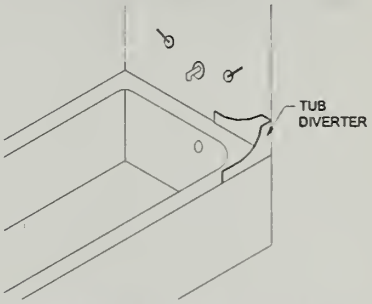
Accessibility

- ☐ Sufficient blocking must be provided in the wall cavity next to bath tubs, showers and toilets to allow for the future installation of grab bars.[9]
- ☐ Consider using showers instead of tubs in some units because some individuals, particularly seniors, have difficulty getting in and out of bathtubs. Roll-in showers can be a tremendous amenity for people with mobility impairments who use wheelchairs.

- ☐ Whenever possible, at least one toilet and sink in each unit should be accessible to persons with mobility impairments who use wheelchairs in order to promote "visitability."

- ☐ Storage areas in accessible or adaptable bathrooms need to be accessible to people with mobility impairments who use wheelchairs.

Fire/Life Safety: Fire alarms ("horns") must be loud enough to be heard everywhere in a unit, including in the bathroom when the fan is on (another reason for using quiet exhaust fans).



A tub diverter is recommended at the ends of the tub to limit splashing or overflow onto adjacent flooring.

General Design Issues

- ☐ Electrical outlets and fixtures typically need ground fault protection on dedicated circuits to comply with Code and to minimize the risk of electrical shock to users.

- ☐ Where possible, provide visual screening of the bathroom from the entry and from the living and dining areas. When more than one bedroom shares a bathroom, consider separating the lavatory from the toilet/tub area to allow use by more than one person.[10]

- ☐ In general, the following "bedroom to bath ratios" has worked well in multifamily affordable housing in San Francisco:

  - o 1-2 bedrooms = 1 bath

  - o 3 bedrooms = 1-1/2 baths (in 2-level units, 1/2 bath on living/kitchen floor).

  - o 4 bedrooms = 2 full baths (in 2-level units, one on each floor).

- ☐ Bathtubs are important for bathing children. Bathtubs should have slip resistant bottoms. In addition, a tub diverter at the ends of the tub can limit splashing or overflow onto adjacent flooring.

- ☐ Approximately 95% of the water leaks in the home are caused by leaky toilets.[11] Even the most efficient toilets need to operate properly in order to conserve water as designed. When "after market" replacement parts are used to repair toilets, the water usage often skyrockets.[12] In order to conserve water, consider selecting toilets that perform well with the replacement parts that maintenance staff are likely to use.

- ☐ All faucets, controls, overflows, etc. should be properly caulked.

1 Some sponsors avoid tile because the grout tends to collect dirt and mildew. In general, solid surfaces are easier to clean.

2 Some sponsors use legs under lavs for additional support. However, support legs tend to create a cleaning problem, and can create a barrier preventing accessibility if the legs are less than 30" wide.

3 The joint between the top of the tub and the bottom of the first row of tile should be caulked. The caulk should be inspected and replaced as necessary as part of an annual maintenance program. See, "The Rehab Guide," HUD, Vol. 6 Kitchens and Baths, sec. 7.2.4 Moisture Control, pg. 61, 1/2000. As noted above, some sponsors dislike tile in units because the grout can become discolored and unsightly when it is not properly maintained. www.huduser.org/publications/destech/rehabgds.html

4 Cal HFA Development Standards state "heat lamps are not to be used since they are not as effective as other heat sources, and the special infrared bulbs are very expensive to replace. Part II, HVAC, pg. 16. www.calhfa.ca.gov/multifamily/financing/app-process/arch-manual.pdf.

5 Title 24 (2001 AB 970), Part 6: Subchapter 4, Sec. 130(b)(2) and Subchapter 7, Sec. 150(k)(2).

6 Particularly for rehabs, windows in lightwells can present privacy concerns and can even present security concerns if the distance between units is not very great.

7 This problem is exacerbated over time when lightwells are used as a "chase" to run plumbing lines and HVAC ducts. In addition, some lightwells have been enclosed at the roof level, thereby undermining, or even defeating, their ability to provide natural light and air to units below.

8 In rehabs it is a good idea to provide an access door from a common hallway to make it easier to periodically clean and maintain lightwells. Otherwise it may be necessary for maintenance staff to access the lightwell through a small window in a private unit on the lowest floor.

9 "A Guide to California Multifamily Disabled Access Regulations," pgs. 72, 73, CBO/HCD, 1/1997. During a rehab, any time the sheetrock is removed from a bathroom wall within the tub surround or adjacent to a toilet, adequate blocking should always be provided within the walls to allow for easy installation of grab bars in the future.

10 See, www.designadvisor.org

11 San Francisco Public Utilities Commission, www.sfwater.org//detail.cfm/MSC_ID/46/MTO_ID/NULL/MC_ID/10/holdSession/1/C_ID/59.

12 See, "Water Closet Performance Testing," Sept. 2002, Seattle Public Utilities, East Bay MUD, NAHB, www.ebmud.com/conserving_&_recycling/toilet_test_report/NAHBRC%20Toilet%20Report.pdf

SRO Rooms

John Martin

This SRO room at Ashbury House includes separate sitting, eating, and sleeping areas.

Single Room Occupancy ("SRO") units are often subjected to heavy use and considerable wear and tear. The following conditions have been observed in an SRO hotel 10 years after its renovation:

- ☐ A pattern of dirt at the entry to the room.
- ☐ Wall hung lavatories ("lavs" or sinks) pulled away from the walls
- ☐ Cabinets below lavs hiding leaking pipes allowing mold to grow while the cabinets and surrounding finishes deteriorate
- ☐ Water damage and mildew at ceilings from leaking plumbing stacks and radiators above.
- ☐ Sprinkler pipes used for hanging plants and sprinkler heads painted over (and therefore not functional).

Key Concepts

Durability and Ease of Maintenance

- ☐ Units designed for individuals who were formally homeless (which is commonly the case with SROs) typically need the most durable components.
- ☐ Floors at the entry door and at lavs should be hard and water resistant, such as linoleum, vinyl (sheet goods or VCT) or wood. Given the small square footage of SRO units, it can be cost effective to continue this same flooring throughout the entire unit.
- ☐ Wall hung lavatories ("lavs" or sinks) are susceptible to "sagging" or even being completely pulled off the wall because they are sometimes used as a seat or ladder. Lavs must be adequately attached to the structural framing or blocking and must be regularly inspected to insure that the caulk line between the lav and the wall is maintained.[1]

Energy Efficiency: All SRO units should have at least one switched fluorescent light. If more than one hardwired light is provided, they all should be fluorescent.

Indoor Air Quality: The problem of roaches, mice and bedbugs in some SROs is severe. Hard surfaced flooring, caulking cracks, and providing vinyl covered mattresses can help to exclude these pests, and thereby promote healthy housing.

Recycling: While hard surface flooring is generally preferable to carpet because of its durability and ease of maintenance, in some cases issues of comfort and perception promote the use of carpeting. When using carpet, consider specifying carpet with recycled content and/or carpet which can be recycled at the end of its life cycle.

1 Some sponsors use legs under lavs for additional support. However, support legs tend to create a cleaning problem, and can create a barrier preventing accessibility if the legs are less than 30" wide.

MATERIALS

Finishes

Interior Paint 111
Carpet 115
Wood Flooring and Alternatives 121
Linoleum 127
Vinyl Flooring 129
Ceramic and Stone Tile 131
Colored Concrete 135

Electrical

Lighting 139
Lighting Controls 145
Photovoltaics 149

Wood

Cabinetry and Millwork 155
Lumber and Alternatives 161

Exterior Envelope

Windows 167

Site

Paving (glossary of terms) 173

Interior Paint

No-VOC intenor paint was used throughout the Drachma Housing Rehab Project in West Oakland.

Traditional oil-based[1] and latex paint[2] contain harmful chemicals and compounds which offgas into the atmosphere, affecting the health of residents and workers, and producing ground level ozone. As the cost of paint is relatively inexpensive compared to the labor to apply it, "greener" paints can offer a significant way to reduce indoor air pollution at little or no extra cost. "Greener" paints have low or zero Volatile Organic Compounds (VOCs). Healthy paint formulas have improved substantially over the last several years so that low and no-VOC paint can perform as well as traditional paint. Most major manufacturers carry lines of low or zero-VOC paint whose cost is comparable to conventional mid to high quality paint. Some "natural paints" don't contain any petroleum products, instead using plant-based resins and chalk-based pigments. Recycled paint is yet another "green" option. LEED Credits can be obtained by using "greener" paints.[3]

Key Concepts

Durability and Ease of Maintenance

Careful preparation is critical to a long lasting paint job with any paint. All surfaces must be clean with visible peeling and cracking removed. When painting an older building, be sure to test for the presence of lead and use appropriate lead safe techniques and disposal methods for the prep work.[4] Consider using high or semi-gloss paints for areas that will need washing, such as kitchens, bathrooms, and children's rooms.

important quote...

"Regardless of the color scheme, whenever I repaint a room, I paint the whole room - trim and walls - antique white semi gloss." - Maintenance staff

For ease of maintenance, the owner may want to establish some type of standardization within and between buildings. In addition, extra supplies should be kept on hand and maintenance manuals should provide supplier information and specify type and location of each paint used.[5]

Indoor Air Quality

Conventional paints release VOCs, which are a major indoor air pollutant as well as serious smog contributor.[6] VOCs are responsible for the distinctive smell of new paint, and commonly cause headaches and allergies. The American Lung Association reports that VOCs can produce a number of more serious health problems such as eye and skin irritation, lung and breathing problems, nausea, muscle weakness and liver and kidney damage.[7] VOCs

Paint components...

Paint consists of three basic components:

- **Pigment** gives the paint its color and sheen.
- **Binder** gives paint hardness, adhesion and resistance properties.
- **Solvent** determines a paint's viscosity and ease of application. It is also what gives paint its odor.

are typically ten times higher indoor than outdoors, and up to 1000 times higher after a new coat of paint. Traditional paints contain a high percentage of VOCs so that they will dry faster. However, most indoor and some outdoor projects can be done using low or no-VOC paints with equal performance.

While all household paints must meet EPA regulations, which call for no more than 250 grams per liter in latex and 380 grams per liter in oil-based paints, these limits are based primarily on reducing ozone formation in the outside air and not on healthy indoor air quality. Many green building experts recommend using paints with no more than 150 grams / liter of VOCs for non-flat paint, and no more than 50 grams / liter of VOCs for flat paint.[8] The back of the paint can lists the VOC level, and greater detail about the paint should be available on the manufacturer's Material Safety Data Sheet (MSDS), often listed on their website.

Perhaps the greatest benefit from using low/no-VOC paint is when painting is performed in an occupied building. Therefore, maintenance staff should be educated about the benefits of low-VOC paint to encourage the ongoing use of such paints even after the building becomes occupied.

Recycling

Recycled content paint provides the environmental benefit of keeping existing paint from the landfill and avoiding the manufacture of new paint. Recycled paint is gathered from household paint collections and consolidated with similar colors to produce larger quantities. This process reduces color choice, and it is likely that recycled paint has a high VOC content.

Resources

"Greener" Paints fact sheet by Green Resource Center.
www.greenresourcecenter.org

GreenSeal is an independent non-profit that rates products that do not contain harmful solvents and verifies VOC limits.
www.greenseal.org

Scientific Certification Systems (SCS) verifies zero-VOC product claims of paint manufacturers. www.scs1.com

HUD Lead Paint Safety: A Field Guide for Painting, Home Maintenance and Renovation Work. www.hud.gov/offices/lead/training/LBPguide.pdf

"American Pride" latex paint is made from castor bean oil, using renewable materials and improving indoor air quality. "2003 Building Green Top-10 Products". www.buildinggreen.com/press/topten/top-10-list.cfm

1 Alkyd paint has replaced what we used to call oil-based paint. Alkyds are synthetic resins that are combined with vegetable oils such as linseed, soya, or tung, to produce clear resins. Alkyd paint has high levels of volatile organic compounds (VOCs), which are carbon-based chemicals that are able to rapidly evaporate.

2 Latex paint is thinned with water, and is the type of paint most commonly used in housing. Two common types of latex are vinyl acrylic latex (PVA) and acrylic latex. Latex paint is available in low and zero VOC.

3 LEED Credits: Materials and Resources Section, MR 4 Recycled Content (for recycled content paints), MR 6 Rapidly Renewable Materials (for milk and plant-based paints); and Indoor Environmental Quality Section, IEQ. 4.2 Low-Emitting Materials (paints).

4 See *HUD Technical Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*, www.hud.gov/offices/lead/guidelines/hudguidelines/index.cfm, as well the more user-friendly guide, *HUD Lead Paint Safety: A Field Guide for Painting, Home Maintenance and Renovation Work*. www.hud.gov/offices/lead/training/LBPguide.pdf

5 Extra supplies should include at least one un-opened can of each color of paint used. The can should be clearly marked with color, area where used, and date. The paint should be stored indoors in a dry location.

6 According to the Environmental Protection Agency, 9% of the airborne pollutants creating ground level ozone come from the VOCs in paint. Low and zero VOC paints have little or no smog-forming emissions ("'Greener' Paints Factsheet, Green Resource Center, greenresourcecenter.org).

7 "Greener" Paints Factsheet, Green Resource Center, www.greenresourcecenter.org.

8 Green Seal requirements for low-VOC paints, http://www.greenseal.org/standards/paints.htm

Carpet

Hamid Hakimi

The nylon carpeting at the Oak Park Apartments in Oakland includes 50% recycled content (25% post consumer content) and can be picked up and recycled at the end of its effective life through a manufacturer sponsored recycling program.

Carpet is made by attaching yarns to a coarse fiber backing. The yarns can be made with natural or synthetic fibers. Likewise, the backing can be comprised of either natural materials (jute, for example) or synthetic components such as polypropylene. Natural fiber carpeting, though not without its environmental costs, is generally considered a more ecologically sensitive product as it is derived from renewable resources and requires less energy to produce than synthetic materials. However, natural carpet is typically more expensive, less readily available, and less durable than synthetic products and for these reasons, it is rarely used in affordable housing. Nylon fiber carpet with a synthetic backing is more commonly used for reasons of cost, durability, and moisture protection.

Carpet comes in two general types: level loop, which has a harder texture and is more durable; and cut pile which has a softer texture that may be appropriate for low traffic areas such as bedrooms in individual units. Combinations of loop and cut pile are also available.

In addition, there are various techniques for dying carpet. "Solution-dyed" carpet is generally the most preferable as color is added to the molten polymers from which the fibers are extruded. The color extends through the yarn, which ensures better color fastness and cleanability and reduces the likelihood of staining. When stains do occur, solution dyed carpet can better withstand the use of powerful cleaning agents, which may damage or cause fading in other types of dyed carpet. Other dyeing methods include: stock dyeing or color applied after the filaments are extruded but prior to spinning; yarn dyeing; piece or continuous dyeing; and printing where color is applied after the yarn has been tufted.[1]

environmental issue...

✓ Wall to wall synthetic floor covering may be one of the worst degraders of Indoor Air Quality. It can off-gas volatile organic compounds (VOCs), and trap dirt and other allergy causing contaminants.

3% of urban landfill volume is carpet

Key Concepts

Durability and Ease of Maintenance

When evaluating initial installation costs, carpet is generally the least expensive flooring option. However, most carpet wears quickly, is easily stained, and requires frequent replacement. It is considered a less durable solution than many hard flooring surfaces such as linoleum, tile, and even vinyl flooring. In addition, carpet is often replaced at unit "turnovers" when tenants leave a unit and before new residents move in. When such replacement occurs before the carpet is completely worn, the effective life span of the carpeting is further reduced and its associated "life cycle costs" increase. When weighing the costs of carpet, it is important to consider not only the initial purchase and installation price, but also the expense and timetable for replacement.

When damaged, carpet can be difficult to patch or repair. Thus, even minor damage or staining can require the replacement of entire rooms of carpeting. One option for minimizing replacement costs is to specify **Carpet Tiles** instead of carpet rolls. Carpet tiles are made in the same manner as carpet but they are applied as individual tiles which can be selectively removed and replaced. This allows for smaller scale repairs and replacement of damaged, stained, or worn areas while permitting the continued use of the undamaged portions of the carpeted area. Replacement costs as well as waste generation is reduced.

Careful selection of locations for carpet installation may further reduce maintenance issues and cut down on replacement costs. Carpet is generally not recommended for high traffic areas such as hallways, lobbies, and community rooms, and should never be specified for areas which are potentially subject to heavy staining (such as trash rooms and adjoining areas) or significant moisture (such as laundry facilities). Carpeting on stairs is especially susceptible to rapid deterioration. Rubber treads are highly durable and, like carpet, will help to control noise.

specification tip...

Consider hard flooring such as wood or linoleum for long-term maintenance and cleanliness, with area rugs for sound control and warmth. The area rugs can be removed and cleaned periodically.

Another option for high-traffic areas is to specify wood or linoleum for long-term maintenance and cleanliness, and employ area rugs or carpet runners for sound control and warmth.[2] The advantage of area rugs and runners is that they can be removed and cleaned periodically and then re-installed, thus avoiding the need to discard worn carpeting and purchase new.

When carpet is installed in areas subject to high use, level loop types are generally preferable as they will not show wear patterns as easily as cut pile carpeting. Some owners elect to use multiple colors of carpeting in high traffic areas. The border of the carpet contrasts with the center of the carpet. This can hide stains and allow for replacement of the high traffic center while allowing the border to remain intact.

Indoor Air Quality

Wall to wall synthetic floor covering may be one of the worst degraders of Indoor Air Quality. Carpet is difficult to clean thoroughly and will tend to trap dust, dirt, fumes, mold, and other allergy-causing contaminants. If carpet becomes wet and is not dried thoroughly within 24 hours, it can support mold and mildew, causing unpleasant odors and possible allergic reactions.[3] Carpet should be vacuumed regularly and cleaned every 12 to 18 months with a commercial grade carpet vacuum or HEPA vacuum (high efficiency particulate air filtered vacuum) to limit the accumulation of contaminants.

In addition to trapped contaminants, the dyes, adhesives and material content of carpet may "off-gas" volatile organic compounds (VOC's) for a period of days to months or even years after installation.[4] Carpeting also has the ability to absorb VOC's from the environment (such as paint, cleaning products, smoke from cigarettes, building materials and furnishings) and slowly re-release them over time.[5] The most intense off-gassing typically occurs during the first 48-72 hours after installation. Though often difficult to schedule, it can be a good idea to let carpeted spaces air out for several days before allowing tenants or residents to occupy them.

Increasingly, carpet products and adhesives are available which are less toxic and release fewer VOC's.[6] Specifying carpet and pads with Carpet and Rug Institute's CRI Green Label will ensure that the product has met standards for low VOC emissions under CRI's Indoor Air Quality Testing Programs.[7]

Carpet removal is often performed in occupied buildings with little or no dust control measures. Carpet removal can significantly degrade IAQ if dust (including leaded dust) and allergens are allowed to migrate into occupied areas.[8] Precautions should be taken during carpet removal to minimize the generation of dust ("safe work practices") and prevent the spread of dust to occupied areas ("containment").

Recycling

The removal and disposal of carpeting is a significant environmental issue. Synthetic carpet can take up to 100 years to decompose, and it is estimated that 3% of urban landfill volume is carpet. More than 2 million tons of carpeting are landfilled every year.[9] One approach to mitigating the negative environmental effects of carpet use and disposal is to recycle carpet at the end of its effective life. Increasingly, programs are available which will pick up both used carpet and carpet pads and deliver them to a recycling center. These reclaimed carpet products serve as raw material either for new carpeting (known as "closed loop recycling") or for other products such as auto parts, plastic lumber, outdoor furniture, etc. (considered "downcycling" or "open loop recycling").

Shopping for Green Carpet...
Courtesy of Green Seal

✓ *Buy refurbished carpet whenever possible;*

✓ *Specify carpet with high overall recycled content;*

✓ *Ask whether environmental leasing or take-back programs are provided to ensure that the carpet will be replaced only as necessary and reused or recycled by the producer;*

✓ *Use carpet tiles where appropriate to extend the life of the installed floor covering;*

✓ *Buy carpet made from recyclable materials and likely to be easily accepted for recycling under existing programs. Carpet containing nylon 6 face fiber and vinyl-backed carpets are currently recyclable. No recycling programs currently exist for polyester carpet;*

✓ *Consider purchasing carpet made of wool or other natural fibers if your primary concern is the use of non-renewable resources.*

continued on next page...

Shopping for Green Guide continued...
Courtesy of Green Seal

✓ *Buy carpet that is solution-dyed;*

✓ *Buy carpet that meets CRI Indoor Air Quality standards (Green Label program);*

✓ *Ensure that low VOC adhesives (CRI certified) are used during installation;*

✓ *Buy a carpet product that is consistent with the desired performance level, expected use pattern, and replacement schedule;*

✓ *Select an appropriate color for the carpet application. Light colors tend to get soiled easily and may require the frequent use of harsh cleaning chemicals and/or replacement.*

www.greenseal.org

The recycling of carpet, however, continues to face many challenges, the most significant of which is the cost of collection, sorting, and transportation of used carpet to recycling centers. Some carpets are more easily recycled than others and some recycling centers will accept only certain types or brands of carpet. Currently, it is estimated that less than 5% of carpet is being recycled.[10] Be sure to ask suppliers about recyclability of their products and the availability of programs which will pick up and/or accept worn carpeting for re-use.[11]

Project sponsors can further support the recycling of carpet by specifying products with recycled content. Recycled content can refer to both "post industrial" waste (the use of carpet trimmings produced during the manufacturing process) and more importantly "post consumer" waste (carpeting which had been used in a commercial or residential application and then is reclaimed for integration into new carpet). Increasingly, carpet manufacturers are offering lines of carpet which include significant quantities of recycled content.

Other Design Considerations

Sound attenuation and Sense of Warmth: Carpet is known for its sound deadening qualities and warmth. These qualities may be particularly important when providing housing for populations accustomed to institutional settings. In residential applications in particular, carpet is valued for its buffering of noise between units.

Softness: Because carpet is soft underfoot and to the touch it is often considered an appropriate choice for flooring in childcare centers for infants and toddlers.

Accessibility: Exposed edges should be fastened to floor surfaces with trim along edge. Carpet with a pile height of over ½" must have a transition ramp between surfaces.

Installation: In general, direct glue down applications are more durable and are considered more appropriate for disabled and senior applications as they are less likely to bunch and create tripping hazards. However, tack-down applications limit the use of adhesives, thereby reducing the potential for VOC off-gassing. The method of carpet installation should not effect its ability to be recycled.

Rehabs & Carpet: Carpet is often favored in rehabs because it can be installed over existing, uneven subfloors.

1 Carpet and Rug Institute, www.carpet-rug.com

2 When using runners or area rugs, be sure to carefully tape or affix carpet edges to hard flooring so as to avoid creating a trip hazard.

3 For a description of methods for addressing water-damaged carpet, as well as repairing and restoring stained carpet, see "Partitions, Ceilings, Floors and Stairs," The Rehab Guide, Vol. 5, by U.S Department of Housing and Urban Development, www.huduser.org/publications/destech/rehabgds.html.

4 "Greener" Carpet, Green Resource Center, www.greenresourcecenter.org

5 The Rehab Guide, Vol. 5.

6 Green Seal is an independent, non-profit organization that strives to achieve a healthier and cleaner environment by identifying and promoting products and services that cause less toxic pollution and waste, conserve resources and habitats, and minimize global warming and ozone depletion. Green seal's standard for industrial adhesives calls for VOC levels of no more than 150 g/l for flooring adhesives. www.greenseal.org.
7 Carpet and Rug Institute, www.carpet-rug.com

8 Very high lead readings from "dust wipes" have been obtained from samples taken from floors after carpeting has been removed. Therefore, carpet removal in buildings constructed before 1978 should be performed in accordance with the protocols described in the HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, Chapter 11, www.hud.gov/offices/lead/guidelines/hudguidelines/index.cfm.

9 Choose Green Report: Carpet, Green Seal, www.greenseal.org

10 California Integrated Waste Management Board, C & D Recycling Program, www.ciwmb.ca.gov.

11 See www.ciwmb.ca.gov/condemo/factsheets/carpet.htm for more information, including a list of recycling centers in California.

Wood Flooring and Alternatives

Cork flooring at 555 Ellis Street in San Francisco provides an attractive, durable surface for the community room

Wood flooring is praised for its aesthetics, warmth, durability and ease of maintenance. Though often considered too expensive for affordable housing, it can be an appropriate flooring choice for community spaces, hallways and common areas. It is available in a variety of wood types, including oak, pine, and maple, and comes in strips (1-1/2" to 3-1/4" widths), planks (3" to 18" widths) or tiles/parquet. Wood flooring can either be "solid" where the wood grain extends through the depth of the plank, or "engineered" where layers of wood are glued together with the grain of each layer running in a different direction. Engineered wood products are advantageous in that they can make use of smaller pieces of wood (thus helping to preserve larger, old-growth trees) and are generally considered to be more dimensionally stable than solid wood flooring. However, the adhesives used in the plank's assembly should be evaluated carefully to minimize the off-gassing of harmful VOC's. In addition, engineered wood flooring may have a shorter lifespan because the depth of the top veneer may permit fewer sanding/refinishing cycles.

The use of wood as a construction material has come under greater scrutiny in recent years. Though it is a common and essential part of standard construction practice in the U.S. (most low-rise and smaller scale buildings in the U.S. are wood-framed), wood, and its extraction through logging, contributes to a variety of environmental problems, such as loss of wildlife habitat, soil degradation and erosion.

Because of the negative environmental impacts associated with traditional logging practices, many project sponsors have begun to look for alternatives to standard wood products. For example, wood products certified by the Forest Stewardship Council (FSC) are increasingly available (see Section 3, Lumber and Alternatives).[1] The FSC oversees a process of certification which recognizes wood derived from sustainably managed forests. Unfortunately, certified wood products tend to be more expensive than typical wood products

specification tip...

Wood, cork, and bamboo flooring contribute to good indoor air quality as they are easy to clean and maintain free of many of the contaminants which can become embedded in carpeting. However, adhesives and sealants used in the manufacture and installation of the products can off-gas harmful VOC's, especially soon after installation. In general, factory applied sealants will off-gas less. Be sure to specify water-based low-VOC adhesives and sealants when choosing wood, cork, and bamboo flooring.

and often they are not as readily available. As the market grows for certified wood and wood products, their price will undoubtedly become increasingly competitive and their availability will increase.

Other alternatives to wood flooring include cork and bamboo. Both products offer many of the advantages of wood: a strong aesthetic, sense of warmth, high durability, and ease of maintenance. In addition, both are manufactured from what are considered to be "rapidly renewable" resources. Bamboo, a type of grass, reaches maturity in just three to seven years (as opposed to 120 years for an oak tree), and cork, which is derived from the outer bark of oak trees, can be harvested every nine to ten years. Though labeled "alternative" products, both materials are being used in affordable housing and have a strong track record of success.

Bamboo: Bamboo is a woody, tall, tropical grass with strong hollow stems which can be used for building products. Recently it has been manufactured as flooring to compete with hardwood flooring. Its looks compare to hardwood floors, with two color choices: natural golden, or a darker, cherry color. It is available as single ply vertical grain, as 2-3 ply horizontal grain or in cross-laminated products. Some products are available with bevels to emphasize individual planks. Initial cost is generally considered to be as high as that for hardwood flooring, which may make it unaffordable. However, like wood, its durability and low maintenance make it's life cycle costs very favorable.[2]

Cork Flooring: Cork comes from the outer bark of the oak tree. It is removed from the tree and combined with binders which hold the cork granules together. A natural product, it can be harvested approximately every 10 years. It typically comes in tile form and in shades of light, medium and dark. Cork provides thermal and acoustical insulation, is resistant to moisture damage and decay, and is soft underfoot. Its cost is comparable to high quality vinyl flooring but it has a life-expectance of four to five times that of vinyl.[3]

Key Concepts

Durability and Ease of Maintenance

Wood, cork and bamboo are all considered to be very durable products with anticipated life-spans of 40 years or more. Wood and bamboo can be sanded and refinished periodically to regain their original appearance, though the number of refinishing cycles will depend on the plank construction and depth and direction of finish grain.[4] Scratched cork flooring can be buffed and resealed, preferably with a low-VOC polyurethane sealer. Unlike sheet products such as vinyl and linoleum, wood, cork and bamboo are less prone to damage by cutting and burning, and if damage does occur, they can typically be repaired through sanding, buffing and resealing. Cork has "memory" and will spring back from compression, though it can be punctured by sharp objects or furniture. Because of the repairability of these flooring products, replacement of the entire floor is rarely necessary thus increasing the life span of the original material and reducing waste generation and replacement costs.[5]

Wood, cork and bamboo can be easily maintained by sweeping or cleaning with a damp mop and mild detergent. Each product should be sealed according to manufacturer's recommendations and many manufacturers produce specially formulated cleaning products for their flooring. However, the use of wood, cork and bamboo in areas susceptible to high levels of moisture should be considered carefully. HUD's *Rehab Guide* reports that most problems with wood flooring are related to lack of routine maintenance or exposure to high levels of moisture or extreme changes in moisture content.[6] Excessive water can seep between boards and into small cracks, causing deterioration of finishes and cupping, crowning or buckling of wood. Similar issues are likely to arise with bamboo and cork floor. It has been reported that wood flooring in the vicinity of existing steam radiator systems can tend to swell. Generally, these products are not recommended for high moisture areas such as communal kitchens and communal bathrooms.

Indoor Air Quality: Hard surfaces such as wood, cork and bamboo are easier to maintain free of dust, mold, and other allergy-causing agents than are softer flooring types such as carpet. For example, contaminants which can be trapped in the fibers of carpet are easily cleaned from the surface of hard-flooring products through routine mopping, dusting and vacuuming. However, adhesives and binders are used in the manufacture of engineered wood flooring, bamboo flooring and cork, and these can include harmful chemicals such as formaldehyde. In addition, all wood flooring and alternatives are sealed with a finish coat that may also off-gas VOC's. While factory applied sealers, or water based finishes will reduce off-gassing, project sponsors

should consider low-VOC and formaldehyde-free adhesives, surface finishing products, and subfloor materials where available.

Other Design Considerations

Installation: Wood and bamboo are available in glue-down, nail-down and floated applications. The moisture content of subfloor surface should be measured prior to installation as excessive moisture will inhibit effectiveness of adhesives in glue-down applications, and may cause warping, cupping or cracking in the product once installed. Wood, bamboo and cork may require more preparation of the subfloor than is typically needed for carpet[7] and may necessitate more lead time as the products should acclimate to their environment prior to installation.

Finishing: Bamboo and wood flooring is available as pre-finished and site-finished strips, planks, and tiles. Both pre-finished and site-finished types can be refinished over time. Common finishes include: water based urethanes, oil-modified urethanes, moisture cured urethanes, swedish finishes, oil finishes, and waxes. In general, water based urethanes are preferable because they provide good durability and contain fewer VOC's than other finishes. In contrast, conventional solvent-based wood finishes can off-gas for months. If solvent-based finishes are used, the floor could be left to off-gas, preferably for 3-4 weeks prior to occupancy.[8] Finally, a low-gloss finish such as satin will tend to hide scratches and other surface damage better than high-gloss finishes.[9]

Rehabs: When removing carpeting or other flooring material as part of a building rehabilitation, consider the possibility of finishing the existing subflooring with an appropriate low-VOC polyurethane finish. It may provide an attractive flooring without the need for investing in additional finish materials.

Sound: In high traffic areas or on stairs, wood and bamboo can be "loud" as footfalls will reverberate off the hard surface. Cork is generally considered to be better at sound attenuation.

1 The Forest Stewardship Council website, www.fscus.org/buying_and_selling/index.html, allows you to search a database for available FSC certified wood products, including wood flooring. Bay Area suppliers are available.

2 For additional information, see "Bamboo Flooring," Green Resource Center, at www.greenresourcecenter.org; "Bamboo Flooring," California Integrated Waste Management Board, Publication #433-03-017, August 2003, at www.ciwmb.ca.gov/publications/greenbuilding/43303017.pdf.

3 For additional information, see "Cork Flooring" Green Resource Center, www.greenresourcecenter.org

4 "For hardwood floors, the National Oak Flooring Manufacturers Association estimates that a typical sanding will remove between 1/64" and 1/32" of wood. Tongue and groove, ¾" oak flooring has 19/64" above the tongue. Therefore a floor could theoretically be sanded and finished 6-10 times or more before the top of the groove is weakened. Under normal conditions, refinishing occurs at approximately 15 year intervals. This suggests that hardwood flooring, if not abused, can last as long as the structure." HUD's The Rehab Guide, "Partitions, Ceilings, Floors and Stairs" Vol. 5, p. 29.

5 For a thorough review of wood flooring repair strategies, see HUD's The Rehab Guide , "Partitions, Ceilings, Floors and Stairs" Vol. 5

6 The Rehab Guide, p. 29

7 Hard surfaces such as wood flooring and alternatives typically require a much "flatter" subfloor than does carpeting. This can sometimes be difficult to achieve in rehabs without significant preparation, such as overlaying the existing subfloor with gypcrete or OSB.

8 "Indoor Air Quality/Finishes" Green Building Guidelines, Alameda County Waste Management Authority, p. 38.

Linoleum

Linoleum comes in a wide variety of colors and can be installed in different patterns. It is a durable, easy to maintain floor finish made from renewable resources

Linoleum is a natural flooring product made from chemically benign, commonly available, and renewable resources such as linseed oil, pine rosin, cork and jute. It comes in sheets and in tiles, and can also be used for countertops and desktops in addition to its more common use as a floor finish. In recent years the product has been re-gaining popularity as an alternative to vinyl flooring because of its longer life span, greater durability, biodegradability, and wide variety of colors and styles.

Though linoleum is considered a responsible choice for flooring from an environmental standpoint, it should be noted that all linoleum is currently manufactured in Europe and thus a considerable amount of energy is consumed in its transport to the US. However, because relatively little energy is expended during its manufacture, the total amount of energy used in production and transportation is considered lower than for most other laminate or hard flooring surfaces.

Key Concepts

Durability and Ease of Maintenance

The durability of linoleum compares to that of more expensive materials like ceramic tile, and typically far exceeds the expected lifespan of vinyl flooring. Properly maintained, linoleum has a life expectancy of 30 to 40 years. Thus, while linoleum is generally more expensive to install than vinyl, this higher initial cost can be recaptured over time in maintenance and replacement savings ("life cycle cost analysis"). The durability and lifespan of linoleum, as is the case for any finish product, will depend in large measure on its appropriate installation. Linoleum is more complicated to install than most vinyl products. Only manufacturer-certified installers should be used.

preferred use...

✓ high traffic areas such as hallways, any areas where wood floors would be used

discouraged use...

× areas where standing water can occur, such as bathrooms

Linoleum is relatively easy to clean and maintain. Linoleum can be finished with a manufacturer's recommended low VOC polyurethane sealant in order to ensure durability, though sealing linoleum is not required. The surface can be cleaned with a wet mop, or with a reusable electrostatic cloth which picks up dirt and dust. Linoleum holds up very well to spills, stains, and nicks and should not stain if burned. Scratches or cuts can be sanded down and filled in a manner similar to wood flooring. Linoleum gets stronger with age and stretches over time making seams tighter rather than pulling them apart (installers should account for this stretching). For these reasons, it is

environmental issues...

✓ unlike sheet vinyl and other synthetic products, linoleum is biodegradable

✓ linoleum is very durable and has a long life expectancy

✓ linoleum is considered a rapidly renewable resource

✗ most linoleum is manufactured in Europe and requires shipping to the US

considered a great flooring product for high traffic areas such as hallways and community rooms, as well as in kitchen areas in individual units. It is generally not recommended for bathrooms or communal kitchens since linoleum can degrade over time when subject to continuous moisture or standing water.

Indoor Air Quality

Linoleum is easier to maintain free of dust, mold, and other allergy-causing agents than are softer flooring types such as carpet. Linseed oil, a component of linoleum, naturally kills bacteria and mold, making linoleum a good choice for kitchens and play areas for children. It does not emit harmful volatile organic compounds (VOC's) as do vinyl flooring products, and low-VOC sealers and adhesives are commonly available. However, the linseed oil used in linoleum's manufacture will off-gas initially and this can affect people with chemical sensibilities (others may find the odor somewhat unpleasant). Where possible, it is a good idea to allow linoleum to "air-out" for a few days before the unit is occupied.

Other Design Considerations

Installation

Since linoleum is more difficult to install than most vinyl flooring products, only certified installers should be used. Linoleum should be allowed to acclimate to the environment in which it will be installed for at least one week prior to installation. A smooth substrate is very important as any irregularities in the subfloor will telegraph through the finish floor. If installing in an existing building with an irregular surface, it may be necessary to first cover the existing surface with ¼" plywood. Linoleum can be installed over a slab or gypcrete, but the subsurface must be tested for water content. If it is too wet, the linoleum may buckle.

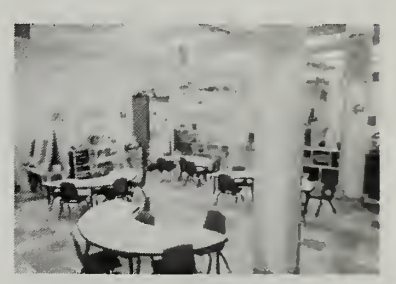
Full glue down application with water-based low-VOC adhesives is recommended. Be sure to use adhesives specifically manufactured for linoleum as opposed to glues made for other sheet products such as vinyl. Linoleum expands and will form bubbles unless fully glued down in place. Heat sealed seams should be specified in damp areas to prohibit water intrusion, though be aware that the heat welding will create a visible seam. Glued seams, by contrast, are virtually invisible.

Design: A large variety of colors and textures are available, and linoleum is available in tile and sheet goods approximately 6' in width.

Resources

Green Resource Center, "Natural Linoleum Flooring"
http://www.greenresourcecenter.org/MaterialsSheets/NaturalLinoleum.html

Vinyl Flooring



The Vinyl Composition Tile used at the Janice Minkitani Family Youth and Childcare Center was slated to be discarded but instead was salvaged and arranged into a random decorative pattern.

Vinyl flooring is comprised of polyvinyl chloride ("PVC"), resins, pigments, and inert fillers. There are two common types of vinyl flooring: sheet vinyl and vinyl tiles. Vinyl tiles, in turn, come in two varieties: vinyl composition tiles, or VCT, which are comprised of vinyl and other fillers and additives, and solid vinyl tiles which have a higher vinyl content and tend to wear longer.

Key Concepts

Durability and Ease of Maintenance

Vinyl flooring is considered an inexpensive and relatively durable flooring material and for this reason is commonly found in affordable housing. Wear and durability, however, will vary according to the type of flooring and quality. In general, commercial grade flooring should be specified for multi-family housing. Vinyl composition tiles are generally the least expensive vinyl option but they are brittle and can crack if subject to heavy or point loads. Solid vinyl tiles are more flexible, more resistant to point loads, and because the wear layer extends through the depth of the tile, they will maintain their finish and color pattern for a longer period of time. If vinyl flooring is specified, sheet vinyl is recommended for all areas where standing water may be an issue, such as bathrooms.

Vinyl flooring typically represents a low initial cost. However, in high use areas such as common bathrooms, hallways, lobbies, common rooms, etc. vinyl products may wear quickly and require frequent replacement, thus increasing the associated "life cycle costs". Vinyl becomes brittle as it ages and is thus more susceptible to cracking over time. Its anticipated life span varies tremendously depending on product and grade. High performance commercial vinyl has warranties of 15 years or longer. These products are sometimes reinforced with quartz or other additives to improve durability. Most vinyl flooring products, however, will have a lower anticipated lifespan than other hard flooring products such as ceramic tile.

Non-porous sheet goods and tiles are relatively easy to maintain and vinyl flooring is no exception. However, sheet vinyl tends to scratch easily, shows cigarette burns and is difficult to repair.[1] Tile products offer the advantage of selective replacement so that when damage occurs, individual tiles can be removed and replaced. For longer wear, ensure that the substrate is smooth and even. Any depressions, holes or cracks should be filled and patched and any protrusions should be removed and the surface sanded smooth. Irregularities in the substrate can cause cracking of the tiles. Also, use of excessive amounts of water for cleaning may lead to the separation of the seams and the exposure of the subfloor to potential water damage.

environmental issue...

✕ Production of vinyl flooring has shown to be hazardous to workers during manufacture and polluting to the environments around manufacturing plants.

Indoor Air Quality

Vinyl flooring is easier to maintain free of dust, mold, and other allergy-causing agents than are softer flooring types such as carpet. However the manufacture of vinyl uses highly toxic chemicals and contributes to pollution in and around manufacturing plants.[2] Vinyl will outgas harmful VOC's once installed, and in the event of a fire, vinyl products can release deadly gases such as hydrogen chloride which turns into hydrochloric acid when inhaled.[3]

Recycling

Vinyl flooring is difficult to recycle at the end of its life cycle. The additives needed to create PVC make large scale mixed product post-consumer recycling nearly impossible.[4] It is not biodegradable and if vinyl is incinerated, heavy metals remain in the ash and must be treated as hazardous waste.[5]

Other Design Considerations

Rehab: Older vinyl flooring may contain asbestos. The asbestos containing vinyl tiles are not considered hazardous to occupants as long as the top layer of the flooring remains undamaged. Asbestos is released only when the second fibrous layer is disturbed.[6] Caution should be taken not to break the fibrous layer when removing existing vinyl flooring during a rehab. Project sponsors should consult with an industrial hygienist to determine whether asbestos is present in existing flooring. Only a certified hazardous material company should remove and dispose of asbestos containing flooring.

Design: VCT and solid vinyl tiles are available in many colors and patterns which permit decorative designs with small additional costs.

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1 For repair techniques for sheet vinyl and vinyl tiles, see HUD's The Rehab Guide, Vol. 5, "Partitions, Ceilings, Floors and Stairs." www.huduser.org/offices/lead/guidelines/hudguidelines/

2 Manufacture of "PVC produces many highly toxic byproducts, including: dioxins, polychlorinated biphenyls (PCBs), and organochlorines. Hundreds of substances known or suspected of causing cancer are produced." Spiegel, Ross, *Green Building Materials: A Guide to Product Selection of Specification*, Wiley: New York, 1999, p. 196

3 "PVC in Buildings: Hazards and Alternatives," Healthy Building Network, www.healthybuilding.net

4 Ibid.

5 Siegel, Ross, *Green Building Materials*, p. 197

6 *The Rehab Guide*, HUD, "Vinyl Sheet Flooring and Tile."

Ceramic and Stone Tile

The lobby and main hallway at the Curry Senior Center in San Francisco uses durable and colorful quarry tile.

Ceramic tiles (a broad category of clay tiles which include porcelain and quarry tiles) and natural stone (such as marble and granite) can be used as floor coverings, wall coverings and countertops, and are appropriate for interior and exterior applications. While products vary in terms of size of tile, finish, thickness, and cost, they share many attributes such as their durability and imperviousness to water.

Key Concepts

Durability and Ease of Maintenance

Ceramic tiles and stone tiles are considered very durable and are especially appropriate as flooring surfaces for areas which receive intense use such as lobbies and community rooms, and in wet areas such as bathrooms and kitchens where they can also be used for countertops and tub surrounds. Though tiles can represent a higher initial cost than other types of materials, this additional cost can be recuperated over time in savings in replacement reserves ("life cycle cost analysis"). Ceramic and stone tile flooring, if properly maintained, will last decades. Their expected life span far exceeds that of carpet or vinyl flooring products, plastic laminate countertops, or fiberglass tub surrounds. Because the material is applied as tiles, selective replacement of the flooring is possible when damage occurs, thus eliminating the need to replace the entire floor, countertop or surround. Stone flooring such as granite or marble tiles are especially durable, and extremely wear-resistant against traffic, spills, burns and water damage. Their higher cost, however, may make them prohibitively expensive except in small areas (such as lobbies) which receive intensive use.

Tiles, despite their durability, can be damaged if not properly cared for. Glazed tiles are subject to scratching and abrasion from traffic or harsh cleaning products. Standing water can degrade grout which can also become eroded over time from traffic and cleaning. Defective or deteriorated construction and substrate can lead to cracking. Floor tiles are also susceptible to cracking when subjected to heavy rolling traffic such as large trash bins.

Tiles should be maintained through damp mopping or vacuuming and the use of a manufacturer approved neutral pH cleaner. Most glazed tile does not require a sealer but some types of unglazed tiles may, so sponsors should check with manufacturers for appropriate sealing instructions. Household cleaners containing acid, bleach or vinegar should be avoided for daily cleaning because they can etch the tile and grout over time. Careful replacement of damaged tiles should be done in a timely manner to avoid water penetration to substrate.[1]

Indoor Air Quality: Ceramic and stone tile are easier to maintain free of dust, mold, and other allergy-causing agents than are softer flooring types such as carpet. Tiles provide a good countertop, floor and wall surfacing material for sponsors wishing to minimize the off-gassing of potentially harmful VOC's (volatile organic compounds). VOC's are commonly associated with the adhesives used to glue down plastic laminate countertops, and with flooring products such as vinyl. Grout lines are more susceptible to mold and staining than tiles themselves. Using a low VOC water based grout sealer will increase resistance to moisture and staining.[2]

Recycling: Ceramic tile is increasingly available which employs up to 100% waste glass. However, these tiles are typically more expensive and thus difficult to include in affordable housing developments.

Other Design Considerations

Rehab: The thickness of tile may pose accessibility problems in existing buildings especially if new tile is installed over an existing finished floor. A small area of sloped floor may be required to avoid a high, steep threshold.

Safety: Stone and ceramic tiles may become slippery when wet. Use of unglazed tiles is strongly recommended in flooring applications because it reduces the chance of slips and accidents. Matte finish floor tiles may be acceptable if smaller tile sizes are used and sufficient grout lines are established to increase friction. Tile suppliers can help to specify slip resistant flooring that meets accessibility standards.

Installation

Tile can be installed in various ways, including: "mortar-set" or "thick set" in which tiles are set in ¾" - 1 ¼" of mortar, or "thin-set" where tiles are placed in an adhesive either over cementitious glass fiber mesh board (commonly called "Wonderboard" or "Durarock"), or over water resistant gypsum board ("greenboard").[3] Mortar set or thin set over cementitious board should be used in showers, tubs or other wet areas. Avoid thin-set tile installation over greenboard in wet areas.[4]

Finally, tiles may look better longer if darker grout is chosen over lighter colors because the grout lines can be difficult to clean and lighter colors will show dirt more easily. All grout should be pre-colored waterproof and must be certified by the manufacturer as suitable.

1 For a thorough description of tile maintenance and repair issues and methods, see "Partitions, Ceilings, Floors and Stairs", Vol. 5, p. 27, and "Kitchens and Baths," Vol. 6, p. 57, of HUD's The Rehab Guide. http://www.huduser.org/publications/destech/rehabgds.html

2 "Recycled-Content Ceramic Tile" Green Resource Center, www.greenresourcecenter.org

3 Tile is part of an assembly which includes grout, mortar bed, and substrate. In order to insure proper installation consult the Tile Council of America's Handbook for Ceramic Tile Installation. Available for purchase at www.tileusa.com/publication_main.htm.

4 Use of tile over greenboard is not permitted in wet areas of projects receiving funding from the San Francisco Mayor's Office of Housing.

Colored Concrete Flooring

Gonzalo Castro

The lobby flooring at Rich Sorro Commons in San Francisco is scored concrete with an applied stain.

Colored concrete flooring provides an elegant and durable finish floor that can be used for lobbies, common areas, corridors or exterior applications. Methods for adding color to concrete include staining, color hardener and color conditioning.

Staining concrete is the process of applying a chemical stain color to a concrete surface. The chemical reacts with the surface of cured concrete to produce a long lasting color. The chemical stain can be applied to the surface of a newly placed (installed) slab or to an existing structural slab, as well as to a topping slab (a finish layer of concrete placed over an existing structural slab). If applied to new concrete, the slab must be allowed to cure for a minimum of 14 days. Stained concrete will telegraph any slab imperfections, slab discolorations or defects. Interior floor surfaces should be protected with a compatible, slip-resistant commercial floor sealant. Two coats of acrylic finish are recommended on top of the sealant. The acrylic finish should be reapplied every year.

Color hardener is a powdered, cementitious material which is incorporated into the surface of freshly placed concrete to create a long lasting colored finish. Two applications are generally necessary, and after each application, the dry color hardener should be worked into the surface by using wooden hand floats or a power trowling machine. A slip-resistant flat-troweled finish is suggested for interior floors.[1] Typically, color hardening systems offer the widest color selection of any permanent concrete coloring method, though they are not suitable for use over self-leveling cementitious toppings. Once applied, the concrete should be cured with an approved wax or concrete sealer. Periodic treatment with commercial floor polishes will help maintain the finish. A chemical stain can be applied to the color hardened surface after it has been completely cured in order to create an uneven, variegated color effect.

Integral colored, or **color-conditioned** concrete employs admixtures mixed directly with the concrete prior to placing. The admixtures disperse color throughout the concrete mix creating an even finish. Color conditioned surfaces should be cured and sealed per manufacturer's recommendations. Some manufacturers recommend the use of a color hardener (see above) for heavily trafficked interior floor applications.

Key Concepts

Durability and Ease of Maintenance

Colored concrete floors are very durable and appropriate for high traffic areas such as hallways, community rooms, lobby spaces, etc. With proper maintenance, the flooring surface can last indefinitely. In choosing to color a concrete slab, project sponsors are in effect exploiting a necessary structural material for use as a finish surface, thus avoiding the financial and material investment in additional finishes such as sheet flooring, tile, carpet, etc. Replacement of those additional finish materials is also avoided, thus reducing the life cycle costs associated with colored concrete.

Colored concrete flooring should be maintained in a similar manner to other hard surfaces: sweeping, mopping, and occasional polishing with a slip-resistant commercial floor polish. In addition, concrete floors, especially in an exterior application, can be hosed down for quick and easy clean-up. A concrete sealer should be applied periodically and according to the manufacturer's recommendation.

Indoor Air Quality

Hard surfaces such as colored concrete are easier to clean and maintain free of dust and allergens than are softer flooring types such as carpet. In addition, concrete flooring does not "off-gas" harmful compounds. However, the process of staining concrete is a highly toxic one which employs powerful acids and creates noxious fumes during application.

Other Design Considerations

Costs: Coloring a concrete slab is not necessarily an inexpensive approach to providing flooring. There is a considerable amount of labor involved both in the application of a color hardener and/or the use of a chemical stain. The avoidance of additional finish materials may be offset by increased costs required for the application of the color. Color conditioned concrete is generally a less expensive approach than using hardeners and stains, though its application is more limited and costs will vary according to the color chosen.

Design: While color conditioned concrete flooring typically requires a monochromatic finish, stains and/or hardeners can be used to create a wide variety of patterns, textures, and finish effects. Staining concrete can create an antique look and narrow saw cuts in the surface of the concrete can define changes in color and simulate the appearance of tile or stone.

Existing Conditions: Imperfections in the surface of the flooring will "telegraph" through and be visible even after the floor has been stained. If a smooth, even finish is desired, newly placed floors must be adequately protected during construction. Existing floor slabs will almost certainly contain imperfections. However, some designers prefer that such imperfections be visible as they contribute to the texture of the flooring and convey a sense of the age and history of the building. Existing older concrete must be cleaned so that the surface is completely penetrable before receiving the initial chemical application. Floors which have been previously treated with sealers, paints, or waxes may need to be sandblasted until such treatments are completely removed.[2] Follow manufacturers' recommendations for preparation of existing concrete floors.

Resources

Concrete Network is an industry sponsored website with information on a host of concrete topics, including acid-etch staining and colored concrete.
http://www.concretenetwork.com/concrete/acid_etch_staining/index.html

L.M Scofield has good selection of products for colored concrete, admixture, stained concrete and color hardener as well as specifications:
http://www.lmscofield.com/

1 LM Scoffield tech data bulletin A-104.12, www.lmscofield.com

2 LM Scoffield Tech Data Bulletin, A-414.08. www.lmscoffield.com

Lighting

High quality, energy efficient lighting can reduce energy and maintenance costs while contributing to a safer and more pleasant living environment. Many people have tried to minimize the use of energy efficient lighting because of problems associated with early versions such as noise (humming or buzzing) and poor light quality (flickering and unnatural colors). Fortunately, these problems have largely been resolved. Energy efficient lighting has virtually eliminated the need for incandescent lighting in affordable multifamily housing.

Common Types of Energy Efficient Lighting

Fluorescent lighting is the most common type of energy efficient lighting used in multifamily housing. It is 3 to 4 times more energy efficient than incandescent lighting. While an incandescent light only requires a lamp (or "bulb"), a fluorescent light needs a lamp (or "tube") and matching ballast to operate properly. New high efficiency electronic ballasts are quiet, quick to light, provide flicker free performance, and don't contain harmful polychlorinated biphenyls (PCBs) frequently found in early fluorescent ballasts. Fluorescent lighting is available in a wide variety of shapes and sizes including 4' long tubes, compact fluorescents ("CFL's") with a pin base, and integral sub-compact fluorescents ("sub-CFL's") with an "Edison" base that screws into fixtures designed for traditional incandescent bulbs.

Halogen provides a bright, very high quality light from a small lamp. Halogen lights can be up to 60% more energy efficient than traditional incandescent lights. Most commonly used in retail, halogen also has residential applications, such as the small "puck lights" that are frequently used for under cabinet lighting.

High Intensity Discharge (HID) is typically used for exterior lighting or for large indoor areas with high ceilings. It is generally more energy efficient than fluorescent lighting, though the quality of light may not be as good. HID includes several specific types of lighting including metal halide and high-pressure sodium.

Light Emitting Diodes (LED) are extremely energy efficient (8 times more efficient than fluorescent), though applications at this time are still quite limited, such as for exit signs and elevator call buttons.

Quality of Light

Glare refers to excessive (relative) brightness, whether direct or reflected. A bare light bulb is a classic source of glare. Glare can result from any light source, including natural sunlight. Lenses, diffusers, louvers, shades, and up lighting are all means to distribute light evenly while shielding lamps from direct viewing, thereby reducing eye fatigue and glare.

Color Temperature is measured in terms of degrees Kelvin (K), and is commonly perceived along a spectrum from "warm" (yellow or red tint, 2,700K to 3,000K) to "cool, bright" (blue tint, 3,500K+) light. Generally speaking, warm lighting is preferred for most housing, while cooler, brighter lighting is favored for senior housing and office spaces. Unless otherwise noted on the packaging, Energy Star rated CFLs are in the 2,700K - 3,000K range, similar to the color of most incandescent light bulbs.

Color Rendering Index (CRI). Color rendition describes the accuracy of the appearance of colors under any given type of lighting. CRI is measured on a scale of 1-100, with natural sunlight ranked at 100, followed closely by incandescent light (including halogen). Generally speaking, a CRI of 80 or higher is considered high quality light. Energy Star rated CFLs have an average CRI of 80 or higher, making them an excellent choice for most lighting applications in affordable multifamily housing.

Key Concepts

Durability and Ease of Maintenance

- ☐ Fluorescent lamps last up to 10 times longer than traditional incandescent bulbs (10,000 hours vs. 1,000 hours), thereby lowering maintenance labor costs to replace burned out lamps.
- ☐ HID lamps can last up to 24,000 hours, or 24 times longer than traditional incandescent bulbs.
- ☐ Ballasts typically last substantially longer than lamps themselves, making lights with separate lamps and ballasts most cost effective.
- ☐ When choosing fixtures for a building, be conscious of the number of different types of lamps (bulbs or tubes) that the fixtures require. Wide varieties of different types of lamps make building maintenance more difficult and expensive.
- ☐ Light fixtures on the exterior, especially those in the public way, can be equipped with vandal resistant features.

Energy Efficiency

- ☐ "Energy Star" fluorescent fixtures and lamps are highly energy efficient (3 to 4 times more efficient than incandescent lights) and provide high quality light.

- ☐ Common 40 watt 4'-0" fluorescent tubes ("T-12") can be replaced ("relamped") with newer "T-8" 32 watt tubes with equivalent light output ("lumens) and lower energy consumption. However, it may also trigger ballast replacement if the existing ballasts are not compatible with the new T-8 tubes.

- ☐ Energy efficiency and life cycle cost savings are maximized when efficient lights are used in applications that require artificial lighting for long periods of time.

Recycling

Any fluorescent ballast that lacks a label stating "Contains No PCBs" (most commonly manufactured before 1979) should be treated as hazardous waste. PCBs are toxic carcinogens that buildup over time (bioaccumulate) in the environment and in organisms (bioconcentrate). PCBs can be ingested, absorbed through the skin, or inhaled. If a ballast suspected of containing PCBs leaks a tar-like material, the room should be vacated, vented and cleaned by trained personnel. Contaminated materials, including cleaning supplies and absorbent materials such as carpet, must be disposed of as hazardous waste.

Virtually all fluorescent lamps contain varying amounts of mercury. Like PCBs, mercury is a persistent and toxic pollutant that bioaccumulates in the environment and the food chain. For a list of local recyclers that accept fluorescent lamps for recycling (for a fee), see SF Environment link below under "Resources."

Other Design Considerations

- ☐ Providing hardwired energy efficient light fixtures throughout units, including living and sleeping areas, reduces the need for tenants to provide their own lights, thereby saving them money while maximizing energy efficiency.

- ☐ Hardwired energy efficient light fixtures will also reduce the use of older, potentially unsafe, tenant supplied lights, such as torchiere style halogen floor lamps. These lamps operate at very high temperatures and have caused several residential fires.

- ☐ Specifying low-mercury lamps reduces the problems associated with fluorescent lamp disposal.

- ☐ For rehab projects, prior to initiating a light fixture replacement program, remove several lights fixtures to visually inspect the existing wiring to evaluate whether it is adequate to allow for the installation of new fixtures.

- ☐ Ninety percent of the total electricity used by a standard incandescent light bulb is wasted as heat. The cooler operating temperatures of fluorescent lights contribute less to overheating of units on hot days.

Resources

Pacific Energy Center, 851 Howard Street, San Francisco, CA, www.pge.com/pec (displays, classes, library, tools, a tremendously knowledgeable staff, and factsheets including: "Anatomy of a Lighting System," "Fluorescent Lamps," "Energy Efficient Fluorescent Ballasts," "Luminaires," "Metal Halide Lamps," and "High Pressure Sodium Lamps").

"Recycling Centers: Lighting Directories, Ballasts, Fluorescent Tubes," SF Environment, www.sfgov.org/sfenvironment/directories/lighting.htm.

"Energy Efficient Lighting," Energy Efficiency and Renewable Energy Network (EREN), US Department of Energy (DOE), (12/1995), www.eren.doe.gov/erec/factsheets/eelight.html.

"Lighting," Energy Star, www.energystar.gov/index.cfm?c=lighting.pr_lighting.

"Electrical," Green Building Guidelines for New Construction, Ch. 4.F, pg. 30, (7/2003 rev.), Alameda County Waste Management Authority (ACWMA), www.stopwaste.org/newhomes-c4.pdf.

"High Efficiency T-8 Fluorescent Lamps," University of Michigan, www.p2000.umich.edu/energy_conservation/ec9.htm.

Recommended Practice for Lighting and the Visual Environment for Senior Living, IESNA RP-28-98, Illuminating Engineering Society of North America (1998).

"How to Buy Energy Efficient Exit Signs," Energy Efficiency and Renewable Energy, Federal Energy Management Program (FEMP), www.eere.energy.gov/femp/procurement/pdfs/exitsign.pdf.

"Mercury," SF Environment Fact Sheet, www.sfgov.org/sfenvironment/facts/mercury.htm.

"Polychlorinated Biphenyls (PCBs)," US Environmental Protection Agency (EPA), www.epa.gov/pcb/index.html.

"PCBs in Fluorescent Light Fixtures: A Fact Sheet," EPA (5/1993).

"Energy Use & Conservation," SF Environment Factsheet, www.sfgov.org/sfenvironment/facts/energy.htm.

Lighting Controls

Lighting controls are devices used to turn lights on and off, or for dimming them. In addition to the ubiquitous "toggle switch" used to manually turn on and off lights, there are also more advanced lighting controls that conserve energy, including: dimmers, occupancy sensors, photocells, and timers. While they are most frequently used in exterior spaces, common areas and office spaces, the use of advanced controls within individual units is increasing.

Common Types of Advanced Lighting Controls

Dimmers. Dimmers are manual or automatic devices that reduce energy consumption by reducing the amount of light that is produced by a fixture. Dimmers may be inappropriate for many types of fluorescent and high intensity discharge (HID) light fixtures.

Occupancy Sensors (or "motion detectors") automatically control lighting, typically in response to a change in heat and/or motion. They are appropriate for areas that are unoccupied for long periods of time. HID lamps with long warm up times may not be appropriate for use with occupancy sensors. The three types of occupancy sensors are: passive infrared (PIR), ultrasonic, or "dual technology."

- ☐ Passive infrared ("PIR") occupancy sensors detect changes in temperature, such as heat radiated by the human body. PIR sensors operate on a "line of sight," and therefore may not be appropriate for a bathroom stall. This type of occupancy sensor typically has the lowest initial cost.

- ☐ Ultrasonic occupancy sensors utilize Doppler signaling, emitting ultrasonic sound waves and measuring the amount of time it takes for the waves to return. Ultrasonic sensors do not depend on line of sight, and can cover a greater area than PIR, but they are more prone to false triggering due to air motion. This is an appropriate technology for rooms with obstructed lines of sight, or with low levels of movement.

- ☐ Dual Technology occupancy sensors combine PIR and ultrasonic sensors and turn on when both sensors are triggered, and remain on as long as either sensor detects occupancy. While more expensive initially, this may be a good choice for rooms where it is critical that the lights do not turn off inadvertently.

Photo Cells automatically control switches or dimmers in response to a change in light levels. Traditionally used to control exterior lighting, photocells are now also being used for "daylighting," to gradually raise and lower indoor lighting in response to changing daylight levels.

Timers. Timers automatically control interior or exterior lights for specified durations ("elapsed time switch"), and/or at scheduled times ("clock switch"). Timers can be mechanical or electronic.

Key Concepts

Durability and Ease of Maintenance

- ☐ In addition to energy conservation, advanced lighting controls also promote lower lifecycle costs by extending the life of fixtures and lamps themselves by automatically turning them off when they are not needed.
- ☐ Photocells and occupancy sensors may need to be adjusted for sensitivity in order to fine-tune their operation.
- ☐ Timers used to control exterior lighting may need periodic adjustment to respond to seasonal time changes of sunrise and sunset.

Energy Efficiency

- ☐ Advanced lighting controls primarily promote lower lifecycle costs through energy conservation by automatically turning off lights when they are not needed.
- ☐ Daylighting (gradually raising and lowering artificial light levels in response to changing levels of available daylight) frequently can be incorporated into the design of new multifamily affordable housing. In addition, lobbies of existing residential hotels and apartment buildings sometimes present rehab daylighting opportunities.
- ☐ Dimming incandescent lamps reduces their light output more than their wattage, making incandescent lamps less efficient as they are dimmed.

Indoor Air Quality

Elapsed time switches are also used to control bath exhaust fans to eliminate excess humidity.

Other Design Considerations

- ☐ An override switch allows users the option of manually control lighting.
- ☐ Occupancy sensors are commonly used for security to turn on exterior lighting when motion is detected.

Resources

Pacific Energy Center, 851 Howard Street, San Francisco, CA, www.pge.com/pec (displays, classes, library, tools, a tremendously knowledgeable staff, and factsheets including: "Automated On/Off" and "Occupancy Controls for Lighting").

"Electrical," Green Building Guidelines for New Construction, Ch. 4.F.3, pg. 30 (7/2003 rev.), Alameda County Waste Management Authority (ACWMA), www.stopwaste.org/newhomes-c4.pdf

"Typical Lighting Control Applications," Energy Efficiency and Renewable Energy Network (EREN), US Department of Energy (DOE), www.eren.doe.gov/femp/procurement/light_controls.html

"Fundamentals of Lighting Controls," The Watt Stopper and DOE's Rebuild America, www.wattstopper.com

"Control the Electric Lights to Exploit Daylighting," 8.3.1, Oikos, www.oikos.com/library/eem/skylights/electric.html

Photovoltaics

Fred Pollack

Nueva Vista Family Housing in Santa Cruz employs photovoltaic panels to offset electricity costs for common areas.

Photovoltaics (PV) are semiconductors which convert energy from the sun into electricity. While PV technology and solar panels met with mixed success when first introduced into residential construction on a large scale in the 1970's, today they are an established and reliable technology that can help to further many of the goals of affordable housing. PV represents a clean, renewable energy source that contributes toward creating a healthy and financially stable residential building. Current government incentives and the inclusion of renewable energy in the basis calculation of the federal low-income housing tax credit program makes PV electric systems feasible on many multifamily projects where they would not have been in the past. The PV market is expanding and there is a wide range of system options, offering the flexibility to meet the specific needs and design constraints of a particular project.

The greatest benefit of including PV in an affordable housing project is that it reduces long-term operating costs. Non-profit entities typically own the development and commit to keeping it affordable for 50 years or more. By installing PV, the owner helps to insulate the development from the volatility of electricity rates, which during an energy crisis can throw operating budgets into disarray and force building managers to reduce other operating expenses to cover the cost of increasing utility bills. PV systems that cover residential units help tenants by reducing the disproportionately high percentage of their income that they pay on utilities. In addition, by showing lower operating costs, it may be possible for the developer to leverage more financing. While long term operating savings and life cycle cost analysis can help to justify an upfront investment in PV, an additional inducement is that at the present time the installation of PV can potentially be fully funded through government incentives and the federal low-income housing tax credit program (see "Funding" below).

How it works: PV, meaning "light voltage," converts sunlight directly into electricity using semi-conductor technology. PV cells are small semiconductors manufactured from crystalline silicon and other thin-film conductive materials. When light hits the PV cell, electrons from the cell's negative layer flow through a circuit to its positive layer, producing electricity.[1] The cells are arranged into a sealed module, which are grouped together into solar panels and arrays. The panels are wired to an inverter that changes the direct current (DC) into alternating current (AC), so that the electricity is suitable for residential use and the electric grid.

While there are battery PV systems that exist off the grid, grid-tied systems are more efficient and make up the bulk of PV systems. California is one of the many states that have a net metering law, which mandates a special metering and billing arrangement between the PV owner and utility company. The owner first uses the electricity generated by the PV system, and any excess electricity generated goes onto the grid, which is credited back to the owner at the same rate when demand exceeds supply (such as at night). The meter shows the net amount used, and the owner is billed annually for the net electricity consumed over a 12-month period. The PV system value may be maximized by entering into a "Time of Use" net metering arrangement with the utility company, whereby the owner can sell energy during the solar peak period (day), and buy back off-peak (night) at a lower cost. Grid-tied systems, it should be noted, do not provide power if the utility power goes down.

The PV system must be sized to meet the needs of the development, and is most efficient in new construction when use of PV is planned from the very beginning. In the case of multifamily housing, many sponsors are electing to install PV systems that will service the electricity needs of common areas. The cost increases significantly to provide solar power to individually metered residential units, as each unit would require its own direct wiring to the panels and a transformer. In addition, in urban, multi-story buildings, it is unlikely that the roof space could accommodate enough panels to service the entire building's electricity needs. However, by providing self generated electricity to service even a portion of the building's common area needs, PV can significantly reduce long-term operating costs of the building.

Key Concepts

Durability and Ease of Maintenance

PV technology is proven to be very durable and requires low maintenance. The panels themselves, once installed, should last up to 30 - 40 years, and typically are warranted to produce at least 80% of their rated power after 20 years.[2] Regular inspections will ensure that the wiring and contacts are intact and that the panels are not obscured. The panels can be washed periodically to prevent dust build-up, although some argue that the benefit is not worth the expense of this simple maintenance. Space should be allocated on the surface on which they are installed to allow access when needed. The inverters are constantly in use, and may require replacement or servicing every 15 years. Battery back-up systems require more maintenance as they involve more components. The inverter required for battery operated systems is a more complex piece of equipment as it must feed the battery as well, and the battery typically needs to be replaced every 5 years.

Energy Efficiency

PV should be installed on buildings that are designed to be as energy efficient as possible. The less electricity that a building requires, the greater the percentage of power that can be generated by the PV system. Recognizing the value of starting with an energy efficient building, the California Energy Commission ("CEC") rebate for affordable housing projects requires that the project has adopted energy efficiency measures as evidenced by receipt of an energy efficiency rebate from the CEC or utility provider.

Whereas sun orientation is important to maximize the PV efficiency, deviations from the ideal angle can still provide an efficient system. South-facing orientation is preferred to maximize annual output, but PV systems that deviate up to 15% from solar south can still collect 90% of the sun's available energy. PV put on a flat roof or on vertical walls collects over 50% to 89% of the sun's available energy.[3] PV technology is offered in a variety of materials, from the traditional solar panels to roofing laminates, to building material integrated photovoltaics. While crystalline silicon solar panel products dominate the market, lower efficiency and less expensive products such as thin-film PV products offer a cheaper and more flexible solution if space is not constrained.

Other Considerations

Funding: Installation of PV can represent a significant initial cost. However, government rebates and incentives, as well as the Federal Low Income Housing Tax Credit Program, administered by TCAC, can help to fund the initial cost for affordable housing developments.

- California Energy Commission's Emerging Renewable Program for Affordable Housing: In 2002, the CEC established a rebate for PV systems installed on affordable housing projects, which can reduce the price significantly. Affordable housing projects may qualify for an extra 25% rebate above the standard rebate, not to exceed 75% of the system cost based on meeting additional eligibility criteria. The project must be individually metered, and funding levels decrease every 6 months. The rebate usually goes directly to the installer, simplifying the payment process for the owner.[4]

- State and Federal Tax Credit: The state and federal governments offer tax credits to reimburse a portion of the net cost. While the non-profit owner can't take advantage of these credits, it may be possible for these credits to be transferable to the investor, so that the project can still benefit from the state and federal tax credits.

- California Tax Credit Allocation Committee ("TCAC"): An increase in basis limits up to 5%[5] is allowed in projects where renewable energy sources such as solar will be implemented. To obtain this increase, the applicant must submit evidence of the savings to be created through the use of the technology, and permission for the increase is granted at the sole discretion of the Executive Director.[6] (For an example of the potential equity value of the TCAC increase in basis limits for sustainable development items, including photovoltaics, please see Section 1, Challenges, Funding.)

Resources

Photovoltaics for Affordable and Cooperative Housing, April 2003. This booklet is a project of the Twin Pines Cooperative Foundation (www.energy.ca.gov/renewables/documents/2003-04-23_FINAL_HOUSE.PDF), and was written to assist affordable housing builders and owners in the PG&E utility area to incorporate PV into a new or existing residential building. It was funded by the California Energy Commission and PG&E.

GRID Alternatives (www.gridalternatives.org) is a Bay Area nonprofit organization whose Solar Affordable Housing Program is designed to help low-income homeowners take advantage of the current state rebate available for

PV installation on affordable housing units. The volunteer based program involves free installation of solar electric systems, job training, technical assistance, and access to low interest financing to pay for the material component of the system.

San Francisco Solar Energy Monitoring Network (www.solarcat.com/sfsolar/main.htm). The San Francisco Public Utilities Commission (PUC) is mapping the sunniest and foggiest neighborhoods of San Francisco in its efforts to position solar panels around the city, as a result of a ballot measure passed in 2001 that allows the city to issue $100 million in revenue bonds for renewable energy systems on public buildings.

California Energy Commission Reports (www.energy.ca.gov/reports/reports_500.html) "A Guide to Photovoltaic (PV) System Design and Installation" and "Buying a Photovoltaic Solar Electric System: A Consumer's Guide."

California Solar Center (www.californiasolarcenter.org) offers resources on PV and solar energy in California, including news, publications, and information on financial incentives.

1 Photovoltaics for Affordable and Cooperative Housing, April 2003, Twin Pines Cooperative Foundation, www.energy.ca.gov/renewables/documents/2003-04-23_FINAL_HOUSE.pdf.

2 Ibid.

3 Basics of PV Electric Systems, KEMA-Xenergy Training, October 2003, PG & E Pacific Energy Center

4 To learn more about the state rebate, call the Energy Call Center at 800-555-7794, or visit the website at www.consumerenergycenter.com/erprebate for application forms, eligible systems, and the CEC Guidebook.

5 Threshold Basis Limits are the maximum specified amount, determined by TCAC on a per unit basis (221(d)(3) limits), that a project can use for calculating tax credits if eligible costs exceed this specified amount. A "basis boost" is an increase in this maximum amount for certain items, such as incorporating renewable energy.

6 See Section 10327 (c)(5)(E) of the federal low-income housing tax credit regulations, www.treasurer.ca.gov/ctcac.

Cabinetry and Millwork

Cabinets with solid wood fronts take stains and paint well and can be sanded and refinished.

Cabinetry is a form of closed storage for food, utensils and other items that helps to keep things organized, out of sight, and protected from dust and vermin. Cabinets are typically manufactured offsite in modular units consisting of one or more "boxes", each including a back and two sides, plus a "face" (front) that includes door or drawer panels. The two basic types of cabinets are traditional face frame and frameless ("Eurostyle"). There is an ongoing debate over which is the "better" design. Regardless of what is specified, some cabinet manufacturers simply submit proposals based on their own standard product. While this may result in the best price, it can make it difficult to compare cabinets from different manufacturers ("apples to oranges"). Unfortunately cabinets designed for single-family market rate housing often are not durable enough to perform adequately under the demands of multifamily affordable housing.

Millwork refers to interior trim such as baseboards, moldings and chair rails. Millwork is often used to visually cover a gap between two surfaces, such as a baseboard used at the bottom of a wall where it meets the floor. Millwork can promote durability. For example, chair rails protect a wall from being damaged by furniture or equipment being moved within a room.

Glossary of Selected Materials

Edge banding is a veneer that is applied to the exposed edges of cabinet frames, doors and drawers. It is most commonly used in frameless cabinets.

Finger jointed lumber is made from short scrap pieces of lumber that are glued together. The finger joint is used to make the glue joint strong. Like most engineered lumber products, finger jointed millwork is very straight, which makes it a good choice for millwork that will be painted.

Medium density fiberboard (MDF) is manufactured from small particles of sawmill waste mixed with a binder (adhesive). MDF is manufactured to very precise dimensions and can be easily routed. It can be painted or covered with plastic laminate or wood veneer. MDF is used for both cabinetry and millwork.

Particleboard is manufactured from larger particles of wood mixed with a binder (adhesive). Particleboard is an inexpensive building material, readily available, and when covered with plastic laminate or wood veneer, the finished surface is easy to clean.

Plywood is manufactured by peeling a continuous veneer from logs. Adhesive is used to bond layers of veneer with alternating grain patterns into panels. Plywood is commonly used in the construction of the most durable cabinet boxes.

Straw particleboard is a relatively new product manufactured using the agricultural waste after harvesting grains such as wheat, rice, oats, and rye. The fibers are pressed into a board with formaldehyde free binders like methyl diisocyanate binders. It is lighter than regular particleboard and mills well.

Key Concepts

Durability and Ease of Maintenance

- ☐ Cabinet Boxes. In general, the sides of cabinet boxes should be constructed from material that is at least 5/8" thick, although ¾" material is preferred for durability. Face frames (when used) should be constructed from ¾" material. Durability is also a function of the type of "joinery" used. For example, tongue and groove joints, and doweled joints, are more durable than joints that are simply glued and stapled.
  - o Plywood is a stronger and more durable material than either particleboard or MDF. In housing designed for families with children or formerly homeless individuals, the higher initial cost of plywood boxes in kitchens or bathrooms can be justified because the cabinets should last longer (life cycle costs).
  - o Straw-based particleboard is a beginning to be used for cabinet boxes. Durability of this product is assumed to be similar to MDF or traditional particleboard.
  - o Particleboard and MDF are the least expensive, and therefore the most commonly used materials for cabinet boxes. When properly manufactured and installed they often perform well in light to medium duty applications (including affordable housing for seniors). However, when particleboard or MDF become wet, they swell and lose strength. In addition, when hardware is pulled out of particleboard or MDF boxes, it may be difficult to reinstall using the existing screw holes.
  - o Steel cabinets are highly durable, though they can dent.

☐ Cabinet Door Faces and Drawers should be constructed from ¾" thick material.

- Solid wood doors and drawers are extremely durable, easy to repair, take screws well, and do not delaminate if they become wet. They are available in paint or stain grades. Some owners prefer stained wood because it can be sanded and painted if it is water damaged.

- Particleboard or MDF doors and drawers covered with a laminate (such as melamine) or veneer (such as birch) often perform well under light to moderate conditions (including use in dry locations such as offices). However, if the hinges are pulled out, it may be difficult to reinstall using existing screw holes. In addition, older particleboard cabinets were notorious for delaminating under high humidity conditions sometimes found in poorly ventilated kitchens.

☐ Cabinet Hardware (hinges) need to be extremely durable to avoid hinge failure which is one of the most common cabinet problems.

- Hinges are either exposed or concealed (Eurostyle). Concealed hinges (also called "cup hinges") are the only type used on frameless cabinets. Both styles are available in extremely durable models.

- Some maintenance personnel prefer simple, exposed barrel style hinges because they are readily available, inexpensive, and easy to replace.

- Others prefer concealed, Eurostyle hinges because they are highly adjustable. Some concealed hinges allow a cabinet door to be easily removed without the use of tools. However, the replacement of concealed hinges may require re-routing of the cabinet box or door panel, a task that can exceed the skills of maintenance staff.

Indoor Air Quality

☐ Vector Control. In order to exclude pests such as cockroaches and mice (both of which have been identified as asthma triggers), and thereby reduce the need to use toxic pesticides, cabinets should have fully sealed backs, and all penetrations and gaps should be sealed. It is particularly important to tightly seal plumbing penetrations into the base cabinet under the sink that, if left unsealed, can allow pests to migrate between units by traveling within the wall cavity. In addition any gaps greater than 1/16", such as between cabinet backs and the wall surface, should be caulked at the perimeter to prevent pests from hiding and breeding in these hidden spaces.

installation tip...

✓ Ensure a tight connection between wall and cabinet and seal all penetrations to exclude pests

- Formaldehyde is a Volatile Organic Chemical ("VOC") that has been identified as a toxic air contaminant that off gasses at normal room temperature.
  - Particleboard (including straw-based particleboard), MDF (Medite II and Medex) and even plywood are increasingly available with no added formaldehyde.
  - Plywood is commonly manufactured with either urea-formaldehyde or phenol-formaldehyde. Phenol-formaldehyde is most commonly used in exterior grade plywood to help waterproof the wood. Phenol-formaldehyde off gasses more slowly than urea-formaldehyde and therefore exterior grade plywood is preferred for IAQ purposes.
  - If materials with added formaldehyde are used (particleboard, MDF or plywood), they should be completely sealed on all sides, preferably with low-VOC adhesives (for example when the material is sealed with melamine) or sealants (such as varnish or paint). Finishing cabinets with sealants offsite also helps to protect IAQ within multifamily housing.
- Mold. As noted above, when particleboard or MDF cabinets are exposed to water, they may begin to delaminate (particularly at the edge banding). If this happens, the underlying particleboard or MDF substrate may become wet, providing an excellent medium for the growth of mold, another proven asthma trigger.

Recycling

MDF and Particleboard (including straw-based particleboard) are both made with recycled products (saw mill waste). Finger jointing allows short scraps of lumber to be recycled into high quality millwork.

Other Design Considerations

Certified Products. Plywood, MDF and particleboard are all available with independent third-party certification (such as the Forest Stewardship Council, or "FSC") demonstrating that they have been manufactured in a sustainable manner.

Accessibility. Hardware pulls (for doors and drawers) should be accessible and easily opened by people with differing abilities, without the need for tight grasping or pinching.

Fire Safety. Varnished cabinets over a stove pose can present a fire hazard. A ducted range hood over the stove addresses this fire safety issue while protecting IAQ.

Resources

"Minimum Cabinet Specifications," California Housing Finance Agency, Multifamily Programs, Architectural Processing Requirements, Attachment 1, www.calhfa.ca.gov/multifamily/financing/app-process/arch-manual.pdf.

"Indoor Air Quality/Finishes," Green Building Guidelines for New Home Construction, pgs. 38-40, Alameda County Waste Management District, www.stopwaste.org.

"Improve Indoor Air Quality with Cabinetry," HUD Rehab Guide Vol. 6: Kitchens & Baths, pg. 23, (1/2000), www.huduser.org/Publications/PDF/kitchen.pdf.

"Particleboard and Medium Density Fiberboard," Green Report, Green Seal, 10/2001, http://www.greenseal.org/cgrs/CGR_PB%26MDF.pdf.

"Straw Particleboard," Advanced Building and Technology Practices, http://www.advancedbuildings.org/main_t_finishes_straw_particleboard.htm.

Forest Stewardship Council United States, www.fscus.org.

"Manual of Millwork," Woodwork Institute, www.wicnet.org.

Kitchen Cabinet Manufacturers Association, www.kcma.org.

"Case Systems Switches to Straw-Based Particleboard," Environmental Building News, Vol. 12, No. 11 (11/2003), pgs. 7-8, www.BuildingGreen.com.

Gibson, Scott, "An Inside Look at Kitchen Cabinets," Renovating a Kitchen, pgs. 115-123, The Taunton Press (2003).

Lumber and Alternatives

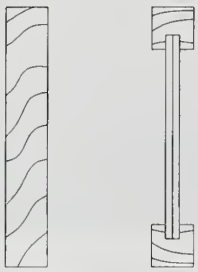
The planter boxes at the Drachma Housing project in West Oakland were made with Wolmanized Natural Select treated lumber, an arsenic-free alternative to CCA treated wood.

The traditional framing material for low-rise residential construction in the U.S. is dimensional lumber. Dimensional lumber refers to framing members which are milled from logs and which come in a multitude of pre-cut lengths and dimensions ranging from 2x4's and 2x6's commonly used for wall framing ("studs"), deeper dimensioned members such as 2x12's and 2x14's used for floor framing ("joists") and larger members used for longer structural spans and loads ("timbers").

Lumber is easy to build with and typically represents a lower initial cost than other framing materials such as light gauge steel. It can be cut and modified on site, and future remodels are relatively easy when working with wood framing. It is low in conductivity and can contribute to good insulation values when used as part of an exterior wall assembly. Most contractors are very familiar with wood framing techniques and this familiarity can further reduce costs.

However, wood is susceptible to rot and deterioration, in particular if it is used without appropriate flashing and waterproofing details. Termites and other insects can also cause extensive damage. In certain applications such as mud sills, wood must be chemically treated, and available treatments are often toxic in nature. And while wood is a renewable resource, methods of timber extraction vary greatly from region to region as do their effects on the surrounding environment. Logging can result in considerable habitat loss, deforestation, and erosion.

In certain applications, alternatives to dimensional lumber can and should be considered. These alternatives can make more efficient use of wood and even reduce or eliminate its use in favor of recycled synthetic materials. They may use fewer toxics, promote sustainable forestry practices, or address issues of dry rot and susceptibility to insects. Alternatives to dimensional lumber discussed below are: engineered lumber, certified lumber, treated lumber, composite and plastic lumber, and steel framing.



2x solid lumber TJI beam

Engineered lumber products such as the I-joist shown at right use less material to achieve the same structural spans. In addition, engineered products can exploit faster-growing smaller trees thus helping to preserve old-growth forests.

Engineered Lumber: Engineered Lumber is structurally configured strands, chips, veneers, or dimensional lumber bonded with adhesives to form alternate dimensions. Engineered lumber includes sheathing products like plywood and OSB, beams, posts, studs, and truss systems all of which are calculated for various structural applications. From an environmental standpoint, one of the principal advantages of engineered lumber is that these products can exploit smaller, fast-growing trees for their manufacture, thereby reducing the harvesting of large old growth trees which are often used for dimensional lumber. In addition, because they are engineered to account for specific stresses and loads, engineered products typically use less material to achieve the same spanning capacities as lumber. Because of these advantages, many engineered products, such as OSB board, plywood, and engineered floor joists, are now commonly used in construction practice.

Glossary of Engineered Products

Oriented Strand Board(OSB): A panel product composed of cross oriented fibers bonded together. OSB is available in typical plywood dimensions and used in similar applications such as for subfloor, roof decking, exterior sheathing, etc.

Truss joist I beams (TJIs): These beams have a solid lumber cord sandwiching a web of oriented strand board filler (see drawing at left) and are commonly used for flooring and roofing systems. These joists have their own restrictions regarding knockouts.

Glue Laminated Beams: A glue laminate beam is formed by bonding layers of dimensional lumber to form a built-up beam which can span long distances.

Parallel Strand Lumber: The strands of clear sapwood from the outer portions of trees or defect veneers are cut into 1 inch by 8 foot lengths and bonded together with adhesives to form the stiffest and strongest engineered lumber. This lumber has a higher adhesive density than others and may have slightly higher wear and tear on saw blades. They are used as headers above door and window openings, and as long span beams.

Laminated Strand Lumber(LSL): LSL is a structural composite of long strands from fast growing underutilized trees. LSL is used for short span headers, stud, plates, posts, rim joists because it is reliably straight

Laminated Veneer lumber (LVL): LVL is comprised of layers of kiln dried wood veneer taken from outer layer of log. It can take large spans and is typically used between girders and/or headers. It has a plywood look with a parallel orientation. Typically, LVL uses Douglas Fir, Southern Pine, Western Hemlock, and Yellow Poplar.

environmental issue...

✕ Urea formaldehyde, a common adhesive in engineered wood products, is more toxic and off-gasses for a longer period of time than phenol formaldehyde. Ask your supplier about binder content for engineered wood products or specify exterior grade plywood which uses phenol formaldehyde even for interior applications.

Certified Lumber

Certified lumber, including dimensional lumber, plywood, and engineered wood products, is lumber that has received third party certification of compliance with sustainable forestry standards. **Sustainable forestry** refers to logging practices which minimize or eliminate many of the detrimental environmental impacts which can result from traditional logging practices such as habitat destruction, soil contamination from pesticides, erosion, and monoculture. In contrast, sustainable forestry enhances biodiversity and wildlife habitat, requires monitoring of forest health, emphasizes respect for indigenous people's rights, and supports community relations and workers' rights.

Often, forests are managed solely on a short-term economic scale without addressing future harvest, erosion of topsoil and other environmental and social issues. Lumber which is "certified" meets the rigorous standards of a wood certification program, the most widely endorsed of which is the Forest Stewardship Council (FSC) -an international non-profit organization founded in 1993 to support environmentally, socially, economically sustainable management of the world's forests.[1] FSC accredits third party organizations who in turn certify companies which meet the performance standards. Unfortunately, because companies have to pay for certification and often have to stop production in order to become certified, costs associated with certified lumber tend to be higher than typical dimensional lumber. However, as the market for certified lumber increase, prices will become more in line with other lumber products.

When specifying certified wood, project sponsors should recognize that certified products are not as readily available as uncertified wood. It is thus a good idea to specify percentage goals rather than require that it be used 100% of the time. (For example, LEED certification requires that 50% of all wood-based materials be FSC certified.) This will allow the contractor to get a small supply of lumber if needed to keep the project moving forward.

Treated Lumber

Treated wood or "pressure-treated" wood is injected with chemicals to reduce the potential of dry rot or fire. It has a green or brown color and often has knife cuts along its surface. Treated lumber is available in dimensional lumber as well as plywood and is typically used for exterior applications where exposure to the elements or soil contact is likely (for example: playground equipment, decks, landscaping ties, planter boxes, fence posts, etc.)

environmental issue...

✕ CCA treated wood is difficult to dispose of after its useful life. Incineration of the material will release harmful toxins into the air. If landfilled, the wood will continue to leach arsenic into the soil threatening groundwater.

For years, the most common type of preservation treatment was **CCA** which stands for Chromate (a bactericide), Copper (a fungicide), and Arsenic (an insecticide).[2] However, on February 12, 2002 the EPA established a voluntary industry phase-out of CCA treated lumber in specified residential uses such as decks, playgrounds, docks, picnic benches, etc. As of January 2004, CCA is no longer available for most residential uses, though it will continue to be available for many industrial and commercial applications. Two of the major alternatives to CCA-treated wood are: Copper Boron Azole (CBA which is also called "Wolmanized **Natural Select**") and Alkaline Copper Quartenary (**ACQ**). CBA and ACQ treated lumber are significantly less toxic than arsenic though they are currently more expensive than CCA.

Decay resistant woods such as redwood or cedar which are naturally resistant to the effects of weather, insects and fungus, offer an additional alternative to CCA treated lumber. No chemicals are used in their preparation and they pose no known health risks. Unfortunately, their cost is generally too high for use in most affordable housing.

Composite and Plastic Lumber

Composite lumber or decking is manufactured using recycled plastic resin and wood fiber (the fiber used may or may not be a waste product - check with the manufacturer). **Plastic** lumber is manufactured with recycled plastic. Both products can be used in place of traditional wood species and pressure treated lumber for outdoor decks, furniture and play structures. Although both products have a higher initial cost, they can be more affordable in the long run ("life cycle costs") because they do not rot, split, crack or absorb water. Plastic lumber and composite decking are environmentally preferable because they recycle plastic, a waste product, and because they do not require annual staining, which eliminates off-gassing of "VOC's" (as well as the associated maintenance costs).

Neither plastic lumber nor composite lumber, however, are approved for structural applications. They typically have lower span ratings than wood and therefore require horizontal support framing to be spaced more closely together. Plastic lumber has greater thermal expansion and contraction than wood and will require greater spacing between decking members.

Steel Framing vs. Wood Framing

Considerable debate exists as to the advantages of steel framing over wood framing. Steel framing employs light gauge galvanized steel members instead of dimensional lumber for the framing of a building. While certain applications require steel because of fire-ratings, increasingly contractors and developers are choosing to use light gauge steel framing in low rise residential applications citing its dimensional stability, insect resistance, and potential to be recycled. Unlike wood, steel does not rot and is immune to the effects of termites and other wood-boring insects. Also, steel framing typically includes significant recycled content (at minimum 20-25%) and it is easily separated from other demolition debris at the end of its lifecycle which facilitates its recycling and reuse.

However, there are several disadvantages associated with light gauge steel framing that need to be evaluated carefully. While steel is easily recycled, it is very energy intensive to produce. It is manufactured from non-renewable resources and its extraction through mining has significant negative environmental impacts. Perhaps most significantly for project owners and property managers, steel is a thermally conductive material that can provide a "bridge" for the transfer of heat through the wall assembly, thus lowering the insulation value, or R-value, of the wall. Steel framed exterior walls, without appropriate detailing, can have a much lower effective R-value than a wood framed building using the same insulating material. This heat loss will result in increased energy costs over the life of the building. Adding continuous rigid insulation at the exterior is one way to combat this problem but the additional insulation costs then must be added to the overall costs for the wall assembly.[3]

1 There are five sustainable forestry standards available to forest companies in the U.S. and Canada: International Organization for Standardization, Canadian Standards Association, Sustainable Forestry Initiative, American Tree Farm System, and the Forestry Stewardship Council.

2 Arsenic, a component of CCA treated lumber, is a known human carcinogen which can cause a wide range of adverse health effects. Children are particularly susceptible to the effects of arsenic and often are at increased risk of exposure due to the prevalence of CCA-treated wood in playground equipment. In addition, disposal of CCA treated lumber is problematic as it will continue to leach arsenic and contaminate the soil if buried in a landfill. It is not suitable for mulch and is toxic if burned.

3 For an in depth comparison of Steel Framing to Wood Framing, see, "Steel or Wood Framing: Which Way Should We Go," *Environmental Building News*, Volume 3, No. 4., available at www.buildinggreen.com.

Windows

Dual glazed single-hung vinyl windows at this historic affordable housing rehab in West Oakland provide an economical and energy-saving window which approximates the profile of a traditional single glazed, double hung wood window.

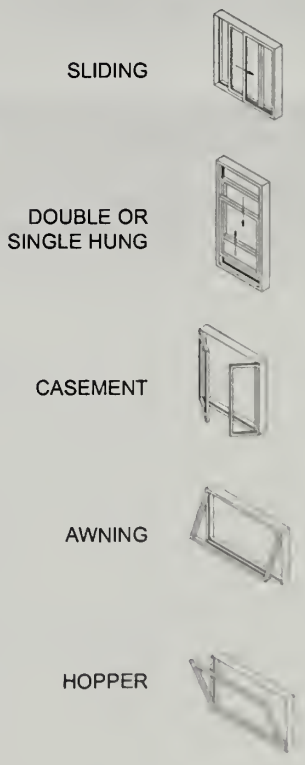
Choosing an appropriate window requires evaluating a variety of criteria. A typical window should be both durable and easy to maintain while providing good thermal protection to ensure an energy efficient building envelope. Light should pass freely through the glazing (glass) to allow for a well-lighted interior during the day, though unwanted heat gain should be minimized so that a comfortable temperature is easy to maintain. Windows should be operable by persons with disabilities, but may also need to be designed to limit a child's ability to open them. They must provide security against intruders, but in many cases also allow for easy egress in case of an emergency. Finally, windows must be both economical (low initial cost) and long lasting (low life cycle costs).

Glossary of Window Frame Materials

- **Vinyl** frames are made from PVC (poly vinyl chloride) which is mixed with dyes and additives to increase resistance to ultraviolet radiation and impact. Vinyl is considered to be an inexpensive and durable window frame material with low maintenance requirements. It provides good thermal performance, thereby limiting condensation. Larger vinyl windows, however, require additional structural support using a stiffer material which can increase the initial cost and reduce thermal performance. Vinyl windows mimic the "look" of wood frames, making them a good choice where there are tight budget constraints and an interest in matching the profile of older wood windows. Vinyl windows have limited color selection and typically are not painted.

- **Aluminum** can be a strong, durable, and relatively inexpensive window frame option. Because aluminum is more rigid than vinyl, the frames require a narrower profile to achieve the same strength, especially when used in a single glazed application. In order improve thermal insulation, aluminum frames can include a "thermal break," typically a hardened polyurethane channel which separates the interior and exterior aluminum extrusion and limits the transfer of heat across the profile of the frame.

- **Wood** is a traditional framing material for residential windows. They are strong, durable, but relatively expensive. They combine good appearance and good thermal performance, and can be painted or stained virtually any color.



- **Other**: Steel frames are very durable. They are often used in commercial and industrial buildings. Composite frames are made of a new generation of wood scrap/polymer composites that are very stable, have equivalent or better structural and thermal properties than conventional wood, with superior moisture and decay resistance. They can be textured, stained or painted. Fiberglass frames are very stable, stronger than vinyl, and have thermal performance similar to insulated vinyl frame. Finally, hybrid frames use two or more frame materials to provide the benefits of each material. Examples of hybrid frames are wood windows with aluminum or vinyl cladding, and vinyl windows with interior wood veneers to provide an attractive interior finish.

specification tip...

The energy efficiency of new windows can easily be evaluated by reviewing the National Fenestration Rating Council ("NFRC") rating. ww.nfrc.org.

Key Concepts

Durability and Ease of Maintenance

Wood windows regularly last more than a hundred years. However, regular maintenance including painting is required to ensure their continued performance as wood is susceptible to deterioration by ultraviolet radiation and exposure to water (dry rot). Modern vinyl, aluminum and "clad" windows on the other hand require very little maintenance.

Energy Efficiency

The National Fenestration Rating Council (NFRC) analyzes the performance of an entire window assembly (including the frame and glazing). All projects should specify windows based on NFRC ratings.

The NFRC label rates:

- U-factor. U-factor is a measure of how well a window retains heat inside a building. The lower the U-Factor, the better the window is at keeping heat in the building. In San Francisco, the U-factor should be .40 or less in order to achieve an energy star rating.[1]

- SHGC (Solar Heat Gain Coefficient). SHGC measures a window's ability to block solar heating of the building. The lower the SHGC, the better the window is at blocking heat gain. Any portion of a building that is air-conditioned and has a South or West facing windows should have an SHGC rating of about .40 or less.[2]

- Visible Transmittance (VT). Visual Transmittance measures how much light the window lets in. A higher VT rating will maximize daylight and view. Select windows with .50 or more.

- Air Leakage (AL). This optional rating (manufacturer's are not required to include it) measures air infiltration through cracks in the window assembly. Select windows with an AL rating of .30 or less.

- Condensation Resistance (CR). Also an optional rating, CR measures the ability of a product to resist the formation of condensation on the interior surface.

A "Low-emittance" (Low-E) coating is a virtually invisible metal or metallic oxide layer deposited on the glazing surface primarily to reduce the U-factor by lowering heat flow through the window. Different types of Low-E coatings have been designed to allow for different levels of solar gain, depending on the demands of the local climate.

The "Energy Star" designation for products meeting certain energy performance criteria varies by climate. When comparing among different Energy Star products, use the NFRC label to compare window performance.

specification tip...

As a general rule, dual glazed windows with a low-E coating are a good choice for San Francisco.

Indoor Air Quality

Mold sometimes forms on and around window frames. Molds are associated with a variety of health problems including allergies, respiratory problems, headaches, nosebleeds, etc. Like humans, molds require food (any organic material) and water (moisture) in order to survive. Windows can be a source of moisture, either because of water penetration where windows and walls meet, or because of condensation due to temperature differentials between indoors and out. Proper detailing and flashing will help to minimize the potential for water to seep into the wall cavity, thereby limiting one source of moisture that could allow mold to grow.

design tip...

Operable windows can improve indoor air quality by allowing for natural ventilation.

Choosing windows with insulating frames will help to limit the potential for condensation to occur at the interior side of the window. Vinyl and wood framed windows are relatively good insulators because of their inherent properties. Aluminum, on the other hand, is not a good insulator. Instead it is a highly conductive material and this conductivity contributes not only to heat loss, but also to the tendency for moisture to accumulate at the cold interior surface of the frame (condensation). Therefore, when specifying aluminum windows it is a good idea to include a thermal break (described above) to limit heat loss and condensation.

environmental issues...

Evaluating the environmental effects of window selection can be a complex endeavor. The production of window frames often has significant negative environmental impacts. Vinyl windows are made with PVC (poly vinyl chloride) which is has been found to be detrimental to workers during its manufacture and a contributor to poor regional air quality near manufacturing plants. Aluminum is fabricated from bauxite, a mineral found primarily in tropical areas and its extraction is a significant factor in the clearcutting of tropical rain forests. Wood is a natural renewable resource but standard logging practices can contribute to habitat loss and soil erosion.

However, all durable, energy efficient windows will limit energy use over time as well as reduce the investment of materials in maintenance and replacement. In addition, durable, energy efficient products are a cost-effective choice for precisely the same reasons: energy savings and longevity. By emphasizing durability and energy efficiency when specifying new windows, project sponsors are ensuring that both economic and environmental considerations are taken into account.

Other Design Considerations

Cost

There is a wide variety in the cost of windows ($200 - $1,000+). Aluminum and vinyl can be very close in cost, while wood may be twice as expensive. Low-e coatings can add up to 10% to the cost of the window (although labor costs to install a window are not affected by low-e coatings). For operable windows, sliders are the cheapest, followed by single hung, then double hung, with casement typically being the most expensive.

When evaluating costs, it is important to consider the energy costs of the building over time. Windows, and their relative efficiency, can have a significant effect on the energy performance of the building envelope and associated heating and cooling cost. Better, more efficient windows are available at a relatively small increase in initial cost that will generate substantial savings over time.[3]

Historic Preservation: When historic preservation is an important consideration, existing windows are often repaired on the front of a building, with new windows provided for the remainder of the building. Under these circumstances, the new windows typically will need to be visually similar to the windows being replaced (you may not be allowed to replace wood, double-hung windows with aluminum sliders).

Rehab: While re-use is generally an environmentally preferred option, old wood or steel framed windows are frequently coated with lead-based paint and can present a significant lead hazard. Properly installed new windows can eliminate the lead hazard within the unit, while dramatically improving thermal and acoustic insulation.[4] The initial costs of new windows is so high that window replacement typically cannot be justified solely for energy efficiency reasons.

Safety: Care must be used when replacing bedroom windows to maintain proper fire access / egress dimensions.

Comfort: Windows with good NFRC ratings not only improve energy efficiency, they also improve occupant comfort. A poorly insulated window creates "thermal gradients" within a room, which means that different parts of a room are at different temperatures. Most people have experienced discomfort from sitting next to a cold (or hot) window. In a small room or unit, a window with a good NFRC rating can effectively increase the usable space within a unit by insuring that the area adjacent to the window is comfortable.

Resources

"Selecting Windows for Energy Efficiency," www.windows.lbl.gov/pub/selectingwindows.

Vol. 4, The Rehab Guide: Doors & Windows" (HUD) "Guidelines for the Evaluation and Control of Lead-Based Paint Hazard in Housing," Chapter 11: Interim Controls (HUD)

The Efficient Windows Collaborative. www.efficientwindows.org

The National Fenestration Rating Council. www.nfrc.org

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1 www.energystar.gov/index.cfm?c=windows_doors.pr_crit_windows.

2 Ibid.

3 For cost comparison estimates based on energy performance, see the Efficient Windows Collaborative at www.efficientwindows.org.

4 As with any work that impacts surfaces coated with lead based paint, care must be taken to protect tenants and workers in accordance with the HUD guidelines. www.hud.gov/offices/lead/guidelines/hudguidelines/index.cfm.

Paving

The traditional paving materials for walks, driveways and parking lots are asphalt and concrete. These materials should last for years and can be recycled at the end of their use. There are also a variety of materials being developed as alternative paving. Some are being developed with the goal of providing a porous surface with the associated environmental benefits. Others are impervious but made with non-toxic components. Each alternative paving material has specific installation and maintenance requirements. The first challenge to their widespread use is lack of experience and expertise with these developing technologies. Although experience with alternative paving materials is limited in affordable housing in San Francisco, their environmental benefits are promising. Listed below are descriptions of traditional paving materials and a summary of emerging paving technologies with links to further information.

Traditional Paving

Asphalt Concrete (AC): Asphalt, also known as AC, is the standard in the paving field. It is a black solid or semisolid mixture of bitumen obtained from native deposits or as a petroleum by product. Asphalt can be used as paving, roofing, and waterproofing, and is usually mixed with an aggregate. It is easy to work with, inexpensive, durable, and it meets accessibility requirements. Asphalt can be recycled by being ground up for use as a base material for recycled asphalt concrete. Rubberized asphalt concrete also contains recycled content using crumb rubber from scrap tires mixed with asphalt and aggregate to resurface roadways. Disadvantages associated with asphalt are that removal is often necessary to resurface; it can sink, crack and perform poorly if not properly installed; it softens in hot weather; and, it increases ambient air temperature ("heat island effect"). Asphalt is impervious, causing storm water runoff to the surrounding areas.

Concrete (PCC): Portland Cement Concrete, also known as PCC, is produced by mixing cement, sand, aggregate (usually gravel or crushed stone) and water, plus small amounts of various chemicals called admixtures. Concrete is very durable, lasting longer than asphalt. It can be recycled for use as aggregate base in roads, buildings, or fill. Concrete is more expensive than asphalt, and equally impervious.

Alternative Paving

Porous Pavement: Porous pavement allows rain to pass through it, thereby reducing storm water runoff and improving ground water recharge. The environmental benefits of porous pavement are recognized by the US Green Building Council's LEED rating system which provides site credits to projects using porous pavement that provide no net increase in the rate or quantity of storm water runoff, and to projects that reduce the heat island effect by using an open-grid pavement system. Porous pavement can be used for parking and areas with light traffic, provided that the site conditions are suitable, such as permeable soils, flat or gentle slopes, and room for a permeable stone reservoir beneath the pavement. Porous pavement can also be used for driveways, walkways and paths. Two types of porous pavement are porous asphalt and pervious concrete.

- ☐ Porous asphalt pavement is an open-graded coarse aggregate bonded by asphalt cement which allows water to infiltrate through the interconnected voids into gravel or crushed stone sub base and finally to the soil below.

- ☐ Pervious concrete is made of specially formulated mixtures of cement with uniform, open-graded coarse aggregate and water.

The primary advantages of porous pavement are that it reduces storm water runoff while filtering pollutants. It facilitates groundwater recharge to maintain groundwater levels and base flow in streams. It reduces the need for curbing and storm sewers, thereby conserving land space. However, relatively few pavement engineers and contractors have expertise with this technology. It can require require more maintenance than traditional paving. Also, there is potential groundwater contamination because porous pavement cannot filter certain pollutants such as vehicle fuel. The reservoir underneath must be sized and soil testing for density and permeability is required.

Natural soil pavement: Natural soil pavement is made from locally available aggregate and binders derived from plant byproducts that don't contain petrochemicals, making them ideal for environmentally sensitive areas. Examples of plant-derived aggregate binders are Road Oyl, PolyPavement and Stabilizer.

- ☐ Road Oyl is a proprietary product made with a liquid binder from pine pitch and resin combined with decomposed granite to form a durable "paved" surface. This surface is impervious and behaves much like asphalt, with a slightly loose surface. It can be used for roads, parking lots and pathways. Road Oyl Pavement can cost as much as or more than asphalt, though is less expensive than installed concrete.

The primary advantages of Road Oyl are that it uses recycled products and is excellent for environmentally sensitive sites. It has a nice color varying from gray to dark brown to a golden tan color (as seen at San Francisco's Crissy field). The spray on finish is smooth and can meet ADA accessibility requirements. There is no leaching of petroleum product, and it can be recycled at the end of its life, making a good base material for new paving aggregate. However, it is expensive to use in the San Francisco, due in part to transportation costs since it is mixed and brought from Napa. To increase durability, the sealer may need to be sprayed as often as every 2 years. The installer must be certified, although the distributor can supply a contractor, which will also help to guarantee performance.

- PolyPavement is the trademark name for natural soil pavement: a product made from an environmentally safe water-based polymer emulsion mixed with site soil and tamped to provide a solid "paved surface." Polypavement requires little to no maintenance, and can support heavy traffic. It is twice as strong as asphalt, and no leaching is involved. However, Polypavement is impervious and reacts to water like asphalt; it will take sheet flow but can erode with channel flow. It is not recommended for highly expansive clay soils because as the soil dries, unwanted cracks can occur. It is approximately half the strength of concrete.

- Stabilizer binds aggregate together with a nontoxic powder derived from the byproducts of plantago (Indian Wheat) and creates a pervious, resilient paving surface that resembles well- compacted aggregate. Stabilizer costs less than asphalt, and according to tests done by Stabilizer Solutions, can be 20 degrees cooler than asphalt because its light color reflects heat.

Resources

www.epa.gov/OW-OWM.html/mtb/porouspa.pdf. This EPA article addresses the benefits and challenges of porous pavement. There are several links available at the end of the article.

Cahill Associates is an environmental consulting firm which designs porous pavement parking lots. www.thcahill.com/porous.htm

BuldingGreen.com provides an analysis of the pros and cons of Road Oyl as an alternative to concrete and asphalt at
http://www.buildinggreen.com/products/road_oyl.cfm

SSPC and Stabilizer Solutions are makers of soil stabilization products.
http://www.sspco.org, www.stabilizersolutions.com

Polypavement provides natural soil pavement systems.
www.polypavement.com

RESOURCES

Affordable Housing Design Advisor. A step-by-step guide to affordable housing design. www.designadvisor.org.

Alameda County Waste Management Authority (ACWMA). Sponsors of several green building guides, including a forthcoming document which focuses on multifamily housing. www.stopwaste.org.

Architects, Designers, Planners for Social Responsibility (ADPSR). Advocates for socially responsible development and environmental protection. The Northern California Chapter produces the *Architectural Resource Guide* which provides information on environmentally conscious building materials and techniques. www.adpsr-norcal.org.

Asian Neighborhood Design (AND). A non-profit 501(c)3 organization which provides architecture and planning assistance to community groups and non-profit organizations. www.andnet.org.

Building for Environmental and Economic Sustainability (BEES). Provides software for selecting environmentally preferable materials. www.bfrl.nist.gov/oae/software/bees.html.

California Air Resources Board. Conducts research into the causes of, and solutions to, air pollution. www.arb.ca.gov/homepage.htm.

California Department of Housing and Community Development. Website includes resources for housing education and outreach strategies. www.hcd.ca.gov/hpd/nimby.htm.

California Energy Commission. Information on residential energy efficiency standards. www.energy.ca.gov/title24.

California Housing Financial Agencey (Cal HFA). Architectural processing requirements for multifamily programs. www.calhfa.ca.gov/multifamily/financing/app-process/arch-manual.pdf.

California Integrated Waste Management Board. Website includes information on construction and demolition debris recycling, www.ciwmb.ca.gov/ConDemo/,and a Recycled Content Product Database, www.ciwmb.ca.gov/rcp.

California Tax Credit Allocation Committee (TCAC). Tax Credit application rules and point allocation. www.treasurer.ca.gov/ctcac.

Carpet and Rug Institute ("CRI"). National trade association representing the carpet and rug industry. Sponsors a "Green Label" testing program to identify carpet products that are truly low VOC. www.carpet-rug.com.

Efficient Windows Collaborative. Provides information on energy efficiencies and cost comparisons for window types by region. www.efficientwindows.org.

Energy Star. EPA-sponsored rating system for energy efficient products and buildings. www.energystar.gov.

Environmental Building News. A monthly newsletter reporting on green building materials and systems. Publishes informational website, www.buildinggreen.com, which includes searchable database for selected published articles. Also publishes the *GreenSpec Directory*, a "green" product directory with guideline specifications.

Environmental Protection Agency (EPA). Website includes Indoor Air Quality design tools for schools. www.epa.gov/iaq/index.html.

Global Green. Advocacy and education organization. Publishes *A Blueprint for Greening Affordable Housing: Developer Guidelines for Resource Efficiency and Sustainable Communities*. www.globalgreen.org.

Greenclips. A free email newsletter summarizing recent "green" articles from other sources. www.greendesign.net/greenclips/start.htm.

Green Affordable Housing Coalition. A coalition of San Francisco Bay Area public and private-sector groups committed to incorporating green building practices into affordable housing. Website includes fact sheets, case studies, and links. www.greenaffordablehousing.org.

Green Resource Center. Links consumers with emerging green building industry. Provides fact sheets on a variety of "green" building products. www.greenresourcecenter.org.

Green Seal. A non-profit organization that identifies and promotes environmentally sensitive products and services. www.greenseal.org.

Healthy Building Network. Promotes use of healthier building materials. www.healthybuilding.net.

Home Affordable Sustainability. Practical information and technical assistance aimed at single-family homes, though much of it applies to multifamily housing. www.homesta.org.

National Fenestration Rating Council (NFRC). Provides rating system for glazing in windows, doors, and skylights. www.nfrc.org.

Non Profit Housing Association of Northern California (NPH). Membership-based advocacy, policy, and research organization. www.nonprofithousing.org.

Pacific Energy Center (PEC). Offers classes on energy efficiency and building design and construction.
www.pge.com/003_save_energy/003c_edu_train/pec/003c1_pac_energy.shtml.

San Francisco Department of the Environment (SF ENVIRONMENT). Provides information on City of San Francisco recycling programs, energy efficiency, etc. www.sfgov.org/sfenvironment/index.htm.

San Francisco Mayor's Office of Housing (MOH). Provides funding and support for the construction and preservation of affordable housing. In addition, provides information on City of San Francisco programs, workshops, and reports, as well as the Affordable Housing Information System. www.sfgov.org/moh.

San Francisco Mayor's Office on Disabilities (MOD). Produces "Quick Sheets" which provide easy to understand accessibility design guidelines. www.sfgov.org/site/sfmod_index.asp.

San Francisco Public Health/Environmental Health. "Guidelines for Mold Control." www.cal-iaq.org/mold0107.htm. See also EPA's "A Brief Guide to Mold, Moisture, and Your Home", EPA, www.epa.gov/iaq/molds/moldguide.html.

Seattle Office of Housing. Publishes affordable housing guide entitled: "Sea Green: Greening Seattle's Affordable Housing". www.seattle.gov/housing/07-FreePublications/SeaGreen.pdf.

Strategic Energy Innovations. A small non-profit company focused on helping communities to design and implement energy savings program. www.seiinc.org/who_we_are.html

The Forest Stewardship Council. Allows you to search a database for available FSC certified wood products.
www.fscus.org/buying_and_selling/index.html.

U.S. Department of Energy (DOE). Provides information on alternative energy, energy saving measures, and strategies for sustainable development. www.eere.energy.gov. Programs include: the Energy Efficiency and Renewable Energy Network (EREN), www.eren.doe.gov., the Building Technologies Program. www.eere.energy.gov/buildings, the Rebuild America Program www.rebuild.org and the Center for Excellence for Sustainable Development, www.sustainable.doe.gov.

U.S. Department of Housing and Urban Development (HUD). Extensive website includes "HUD-user" Policy Development and Research Information Service which includes downloadable version of "The Rehab Guide" at www.huduser.org/publications/destech/rehabgui.html, and HUD Guidelines

for the Evaluation and Control of Lead-Based Paint Hazards in Housing. www.hud.gov/offices/lead/guidelines/hudguidelines/index.cfm.

U.S. Green Building Council. A coalition working to promote buildings that are environmentally responsible, profitable and healthy places to live and work. Supports the Leadership in Energy and Environmental Design (LEED) rating system. www.usgbc.org.

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